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# the australian disaster rescue manual

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THE  
AUSTRALIAN  
DISASTER RESCUE MANUAL

1. The purpose of this manual is to provide a reference to emergency rescue principles and functions. It is intended for use in planning, training and operations by all disaster rescue organisations and elements. It supercedes the handbook "Rescue" published in 1975 and the first edition of this title published in 1984 by the Natural Disasters Organisation.
2. This manual has been prepared in consultation with the State and Territory Emergency Services.
3. The manual is issued in loose leaf form to facilitate amendment and insertion of State/Territory supplements.
4. Proposals for changes should be forwarded to the Director General, Natural Disasters Organisation, Department of Defence, PO Box E33, Queen Victoria Terrace, ACT, 2600, by the respective State/Territory counter disaster organisation which is responsible for co-ordinating proposed changes within each State/Territory.



Accession No.	
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DTIC	<input type="checkbox"/>
Unavail.	<input type="checkbox"/>
By	
Issued by	
Availability Codes	
Avail. and/or	
Dist	Special
A-1	

Published by Natural Disasters Organisation  
Second Edition 1988  
ISBN 0 642 97174 4

RECORD OF AMENDMENTS

Amendment Number	Date Issued	Date Inserted	Inserted By	Remarks

## RESCUE HANDBOOK

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## CHAPTER 1

### ORGANISATION, EQUIPMENT AND PLANNING

1.0 The aim of the Rescue Service Team should be:

"To save life and minimise further damage to persons and property in times of disaster."

This statement could of course be one of the aims of the State or Territory Emergency Services as a whole but as the Rescue Service is the section involved in the practical application of the aim, being supported by all other services, the aim holds particularly true for the Rescue Service team. It should be noted, however, that it is team work and co-operation which will achieve the aim, not insular sectionalisation.

1.1 Functions

The primary functions of the Rescue Service Team are:

- (a) To save life by the rapid extrication of trapped persons.
- (b) To administer life saving support to trapped persons during the course of Rescue Operations.

... The Secondary Functions may include:

- (a) Assistance in the recovery of the dead.
- (b) The temporary support, repair or demolition of damaged structures to minimise further damage or disruption.
- (c) Provision of support on request to the Statutory Services, Authorities or Specialist Parties in times of disaster or emergency.
- (d) Ensuring that all personnel are aware of the hazards involved and how to overcome those hazards when dealing with water, gas, electricity or other utilities which could endanger life or impede rescue operations.

1.2 The Psychology of Rescue

A moments reflection is all that is needed to realize that any situation requiring a rescue operation by definition is one which contains either a dangerous or a potentially dangerous element (or elements). Unless an individual faces a dangerous situation - drowning, exposure, starvation, asphyxiation, etc., there is nothing from which to be RESCUED.

People tend to react differently to danger, but the most general responses are anxiety and fear, perhaps the most powerful of all emotions. It must be remembered that it is not just the victim which faces the danger. In order to rescue the victim the rescuer must enter the site of the dangerous situation and face the same danger as the victim. Even if the main danger has struck and has passed, additional dangers are still often present. The biggest difference between the victim and the rescuer is that the rescuer is better able to cope with, or handle, the situation. This is because the rescuer has the knowhow and the resources at his disposal to minimise risk and to remedy the situation.

It is normal to be anxious and feel fear in the face of danger. These are emotional reactions common to both victim and rescuer. Many other emotional responses may become manifest during a rescue situation - pity, disgust, contempt, pride, concern, and many more. These are often exaggerated beyond all reason by the urgency and pressures of the situation, thus lowering the efficiency of the overall operation.

The rescue worker must be aware of the psychological needs of disaster victims, not just their physical needs, and be prepared to meet those psychological needs.

#### Rescue Workers

1.3 An event requiring rescue operations will usually create three categories of "rescue" workers:

- a. Group 1. The immediate reaction of survivors in a disaster situation, once they have discovered they are not seriously injured is to help their mates and families. They usually do not know what to do, but obviously it is a serious situation and thus they feel they must do something.

These good intentions could aggravate the conditions of those being "helped" to the point that the loss of life may be greater than it should be. These same individuals could also tend to get in the way and interrupt the functioning of trained rescue teams, however, uninjured and slightly injured survivors could well be the only hope of survival for many victims, eg, if toxic gases, dangerous chemicals or fire or danger of fire exists at the site of the disaster.

The first group to commence rescue work at the site of a disaster consists of those survivors still physically capable of doing so. The potential for good is enormous but the danger inherent in rescue work by untrained personnel is also enormous.

- b. Group 2. The second "wave" of rescue workers is drawn from people either witnessing the event or from the vicinity of the event, drawn to the site by curiosity and, for many, a desire to assist the victims. Although not quite as emotionally involved as the survivors, the dangers inherent in utilizing untrained personnel are still a factor which must be considered. On the positive side, they often bring necessary resources with them and can be a very effective source of manpower if they can be brought under control and properly supervised.

Unfortunately, a large number of the "curious" are just that. They have no desire to help, but just look. They get in the way, shout advice and generally add to the excitement at the site - the very thing that is needed the least, especially from the standpoint of victims.

- c. Group 3. The last group to arrive at the scene is the trained professional or volunteer rescue worker - Police, Fire, S.E.S., etc. It takes some time for various emergency services to mobilize and arrive at the scene. The more quickly they can arrive at the scene, the less time there will have been for the first two groups to aggravate the situation and create more dangers to surviving victims and to themselves. If well trained, they will know what to do and how to utilize the available resources, material and untrained manpower in efficiently carrying out the necessary tasks in a manner which will not further endanger anyone.

#### 1.4 Personal Traits of the Rescue Worker

Rescue work is not an easy task nor is it necessarily a "glamorous" one. Certainly, not all people are suited to such work. Physical fitness, personality and emotional stability are all factors involved in determining one's suitability.

The rescue worker will ideally be or have:

- (a) Interested - Must be genuinely interested in rescue work not just because of peer pressure, trying to impress, etc.

- (b) Dependable - Lives of victims, and team mates rely upon dependability.
- (c) Appearance - Should instill confidence in the victims.
- (d) Co-operative - Rescue work is usually a team effort hence the ability to co-operate with others is vital.
- (e) Initiative - The nature of rescue operations is such that it is often impossible to closely supervise each team member. He must be able to see for himself what needs doing, set priorities, and do the tasks at hand.
- (f) Adaptable - Each situation is unique. An individual must be able to apply all his skills and knowledge to new situations.
- (g) In Good Physical Condition - Rescue work of any kind is physically demanding and often for long periods. Any physical limitations must be recognized and taken into consideration.
- (h) Capable of Leadership - This requirement falls upon all members at various times and to varying degrees. Through leadership by trained professional or volunteer rescue workers many more intrained volunteers may be utilized in the operations at hand.
- (i) In Control of Fears (Phobias) - It is important that he knows what he can and cannot do. Part of this knowledge consists of being aware of any phobias. It is also vital that any leader of a rescue team knows of any phobias in his team members. More time might be spent trying to care for a team member ordered to do something, of which he is psychologically incapable, than should be necessary to complete the original task. (eg, to send someone afraid of heights up a high ladder could possibly result in having to send four rescuers up the ladder to pry his fingers loose and carry him back down.) By this time it might be too late to save the person who was to be rescued.

Some phobias that could seriously affect a rescue worker are:

1. Fear of the sight of blood
2. Fear of heights
3. Fear of confined spaces
4. Fear of water or drowning.

#### 1.5 Personal Behaviour

The conduct of an individual tells a lot about his psychological make-up or his personality. The nature of rescue work is such that it is particularly important that personal conduct does not aggravate matters, but rather assists in creating a feeling that the situation is in competent hands and everything possible is being done to rescue and care for the victims.

A few of the more important general areas of conduct or behaviour are:

- a. Attitude - A serious, professional attitude must be maintained to gain confidence and support.

Arrogance and superiority  
create instant antagonism.

Loud talking, joking, and horseplay reduce credibility, create a feeling of resentment and disgust and add to the confusion, thus hindering the work and adding to the state of anxiety of the victims. A rescuer cannot consider himself "professional" if he adds to the confusion by loud shouting or frantic gestures.

- b. Emotions - Emotions are hard to control in the best of circumstances. In a disaster situation everything is so intense that to control your emotions is a very difficult task but every effort must be made to prevent emotions gaining control over good judgement and competence. Regardless of the excitement and the severity of the incident the rescuer must be able to remain calm, at least a facade of calmness, and be sympathetic without becoming emotionally involved. Objectivity is all important.

- c. Courteous and Friendly - Courtesy, tact and good judgement are vital if people are concerned. It can be a matter of life or death when dealing with casualties. If the rescue task is to be completed quickly and effectively, the same courtesy must be given to other members of the rescue team and to untrained volunteers. The latter are willing and able, but need your direction if they are to be a help rather than a hindrance.

Perhaps the most sensitive area is the relationship between the various emergency services. Breaches of courtesy in the relationship can have disastrous effects.

1.6

Team Composition

As each State or Territory has its own organisational requirements, this publication cannot detail a Rescue Service Organisation, however, a team of eight is regarded as an ideal combination which includes a Leader and a Deputy Leader. Few techniques require more than eight members to implement.

For smaller tasks such as covering roofs etc, two teams of four can be created; one under each leader, working in close proximity to each other, sharing resources and still being available as a full rescue team should the need arise.

Further information on the composition and organisation of the Rescue Service should be obtained from respective State or Territory Emergency Service Headquarters.

EQUIPMENT

1.7

The Commonwealth Government, through the Natural Disasters Organisation (NDO), funds an Equipment Support Program in support of the State and Territory Local Authority Emergency Services units. The equipment made available under this program is listed on an Approved Equipment List which is distributed to State/Territory headquarters of the Emergency Services. The equipment supplied is supplemented by additional equipment from State and Local Government and community resources as required, depending on local requirements. Annex A to Chapter 1 lists the most commonly used items in use by rescue services.

This list is designed only as a guide and should be added to or subtracted from as local operational requirements dictate.

It should be noted that Rescue Leaders, with the permission of their Local Controller/Co-ordinator, are expected to survey their particular area of responsibility to ascertain the availability of additional equipment should it be required in a time of disaster.

1.8 Radiac Equipment

In the event of war, dosimeters and charging units will be issued to a standard determined by each State Headquarters.

THE RESCUE PLAN

1.9 Successful rescue work depends principally on two things:

- (a) A quick and thorough appraisal of the situation
- (b) A systematic working plan

When working under pressure, it is easy to overestimate or underestimate considerably, the extent of a rescue problem. These errors in estimating, affect decisions being made on manpower requirements, equipment, support services (WELFARE, etc) and other tasks requiring assistance. Therefore, it is essential that the appraisal or reconnaissance be thorough and ongoing throughout the operation.

1.10 Initial Reconnaissance

The team leaders reconnaissance should be aimed at an accurate assessment of:

- (a) The number and location of casualties
- (b) Dangerous situations such as gas, electricity, overhanging walls, unsafe structural components; anything which may endanger rescue members or survivors
- (c) Access to the casualties or task
- (d) The extent and type of the damage
- (e) Resources, both manpower and equipment, available
- (f) The time the task would take with available resources



From this assessment, decisions on the following must be made:

- (a) How many additional men are required?
- (b) What additional equipment is required?
- (c) Is time a critical factor?
- (d) Will public utility support be required?
- (e) How long is it likely to take to complete the task?

It is essential that every member of a rescue team be trained in rescue reconnaissance, as in many instances the team leader may be responsible for a number of tasks and members deployed by him must be capable of conducting reconnaissance and of reporting the observations back to the leader. All sources of information such as relatives, neighbours, police officers etc, should be exploited to obtain information regarding casualties, damage and likely hazards.

#### 1.11 Continuing Action

Having made decisions and deployed team members, team leader must continue reconnaissance with a view to allocating priorities for the further deployment of team members.

Members deployed on a particular building, damaged by blast or natural causes, should make careful observation of how that building has collapsed.

The art of rescue lies in being able to identify and exploit to the maximum, all debris formation such as voids etc, which can be used to facilitate access to the casualty once his whereabouts has been fixed by firm information or inference.

An attempt should be made to locate and identify the parts of the building and especially those parts in which casualties are reported to be. This will enable a rough idea to be obtained as to where casualties might be found in relation to the various parts of the damaged structure.

At times such as this, a leader will need to call upon all his accumulated experience and training and combine them with effective decision making.

#### 1.12 Rescue by Stages

Once again, no standard set of rules can be devised to give leaders sure and specific guidance on how to tackle every job, but by proceeding in stages according to a regular plan they are less liable to overlook important points and more likely to appreciate and

organise appropriate action. The principle of applying the art of reconnaissance to each successive stage will operate throughout. Each stage is so framed as to be generally applicable to any set of circumstances and to any rescue task from start to finish. They are easily memorised by reference to the mnemonic "crest":

- C Clearance of surface casualties
- R Rescue of lightly trapped
- E Exploration of likely survival points
- S Selected debris removal
- T Total debris clearance

1.13 STAGE 1 Clearance of Surface Casualties

The task of caring for casualties is best handled by ambulance or first aid teams, but it could well fall to the rescue party to render assistance and all members should be prepared and trained to care for casualties.

1.14 STAGE 2 Rescue of Lightly Trapped

This involves the recovery of those who are lightly trapped and the searching of slightly damaged buildings to ensure that no casualties within them are unattended.

Once casualties have been seen or heard, or their whereabouts definitely ascertained, every endeavour should be made to maintain contact until they are released.

In carrying out this stage, a speedy but careful examination of the damaged structures is needed in order to determine the best and safest approach. Remember there is always a danger of fire from electricity or gas, therefore rescuers must NOT smoke or use naked flames when searching a building.

Normally the search should commence at the lowest portion of the building and be continued upwards until every possible location in which casualties may be trapped has been explored.

Buildings which have been thoroughly searched should be so marked and the following standard markings be used.

SEARCHED will be written in capital letters in chalk or some readily seen ingredient, near the entrance, indicating that the building has been searched and cleared of casualties. This will be underlined and underneath will be printed the name of the service responsible. Thus:

	<u>SEARCHED</u>		<u>SEARCHED</u>	etc.
		OR		
SES	RESCUE		FIRE SERVICE	

Where searchers find dangerous conditions eg, leaning walls, damaged staircases, escaping gas etc, they should mark DANGER after the searched marking.

eg. SEARCHED DANGER  
SES RESCUE

Buildings in which danger exists should be marked in a prominent position on all sides where entry is likely to be made. In addition to the marks, an improvised barricade with the word DANGER written on it will assist in warning anyone who has an occasion to enter the building.

If debris is present in sufficient quantity to hide casualties, only mark those parts of the building which have been thoroughly searched.

#### 1.15 STAGE 3 Exploration of Likely Survival Points

All likely survival points where persons may have taken refuge and in which they may be trapped, either injured or uninjured, must be searched. Too much stress cannot be laid on the need for searching all likely places for casualties who may still be alive, and of effecting their release before any attempt is made to rescue victims who have little chance of surviving. This does not mean that every nook and cranny must be searched for possible casualties, but likely places must be fully explored.

It should be remembered that casualties may be found who have received severe crush injuries from fallen masonry, brickwork, beams, walls, heavy furniture etc. These persons will be suffering from shock and their breathing passages may be clogged by the dust contained in the debris, in which case these passages must be cleared. Persons suffering from crush injuries need special treatment if practicable, before release.

#### 1.16 Calling and Listening Techniques (Figure 1)

When it is known that persons are still missing, and the rescuers are confronted with a major collapse of premises, the casualties may be trapped within the voids formed by the collapsing building. A "Calling and Listening" period should be introduced; this has in the past saved many lives and is carried out in the following manner; the leader places available team members at suitable vantage points around the area where the persons may be trapped, and then calls out "SILENCE...SILENCE FOR RESCUE", then each member is directed by the leader, calls "RESCUE PARTY HERE...CAN YOU HEAR ME?", while the other members listen intently for any reply. If none is heard it is a good plan to

tap on a wall, or on any gas or water pipe, beam etc, running into the debris, all of which are good conductors of sound, and again listen for an answer. On hearing a reply, each listener points to the place from which he thinks the sound came, thus 'pin-pointing' the position. Once contact has been established with a trapped person, it should be maintained.

1.17 STAGE 4 Selected Debris Removal

If casualties are located, their recovery will entail removing debris according to:

- (a) The location of the casualty
- (b) The layout of the building
- (c) The way in which the building has collapsed

REFER CHAPTERS 7 & 8

1.18 STAGE 5 Total Debris Clearance

Where it is still not possible to account for all missing persons, it may be necessary to strip the site methodically. When debris has been relocated, the pile should be suitably marked (REFER CHAPTER 7).

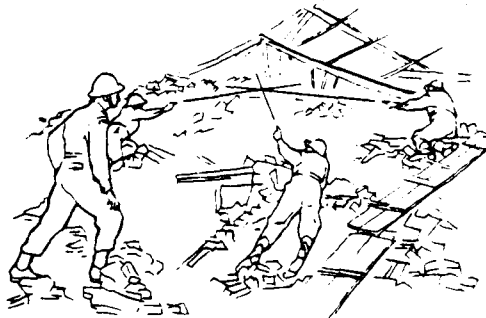


Fig 1. Leader and three team members using Calling and Listening Technique

ANNEX A TO CHAPTER 1

Personal Equipment

BAG, SLEEPING

BOOTS, HIGH LEG

FOULWEATHER CLOTHING - JACKET AND TROUSERS

PACK, GENERAL RESCUE (NOT MANPACK)

PROTECTIVE CAP, WITH/OR WITHOUT VISOR AND EAR MUFFS, ORANGE COLOUR

TENT, 2-3 MAN

PROTECTIVE OVERALLS, ORANGE COLOUR

Man Pack Equipment (issue optional)

- (1) MANPACK, CD PATTERN
- (1) AUGER, 25mm x 355mm
- (2) BANDS, WEBBING
- (1) BAR, WRECKING 600mm
- (1) BLANKET
- (1) BONDWIRE, 6mm x 5m
- (1) CHISEL, COLD, 25mm BLADE, 200mm x 300mm STEM
- (1) CORD, SASH 4-6m
- (1) GLOVES, DEBRIS, HEAVY LEATHER, NO STUDS
- (1) GOGGLES, DUST
- (1) HAMMER, CLUB 1KG
- (1) HATCHET, CASE OPENING
- (1) MASK, DUST
- (1) PLIERS, SIDE CUTTING, INSULATED
- (1) ROPE, 16mm x 12m
- (1) SAW, MULTI PURPOSE

Trailer or Vehicle Equipment

- (1) AIR BAG, 250 AND/OR 500KN
- (1) GENERATING SET, 240VAC, OPTIONAL SIZE  
USUALLY BETWEEN 3000-7000 WATTS
- (1) GENERATING SET, 240VAC 300-1000 WATTS
- (1) AUGER, 25mm x 355mm
- (1) AXE, FELLING 2KG
- (10) BANDS, WEBBING
- (2) BARS, CROW 1.7m CHISEL POINT
- (6) BARS, PICKET 35mm x 1.5m STEEL
- (1) BAR, STEEL
- (2) BARS, WRECKING
- (12) BLANKETS, WOOLLEN
- (1) BLANKET, SPACE
- (6) BOND WIRE, 4mm x 5m
- (1) BLOCK, SNATCH, 203mm SWR (FOR TIRFOR)
- (3) BLOCK, SINGLE SHEAVE, 24mm FIBRE ROPE
- (1) BLOCK, 2 SHEAVE, 24mm FIBRE ROPE
- (1) BLOCK, 3 SHEAVE, 24mm FIBRE ROPE
- (8) BOTTLES, WATER
- (1) BOX, NAILS - MIXED 1KG x 50mm  
MIXED 1KG x 80mm  
MIXED 1KG x 100mm  
MIXED 1KG x LEADHEAD ROOFING
- (2) BUCKETS
- (1) CHAIN, 1.8m x 7mm WITH RING AND HOOK, TESTED 32.1KN
- (1) CHAIN, 1.8m WITH RING AND HOOK, TESTED 7.5KN
- (1) CHISEL, COLD, 25mm BLADE 200mm - 300mm STEM
- (12) CORD, SASH 4-6m x 10mm
- (1) CUTTERS, BOLT 16mm x 914mm

- (1) CHISEL, PLUGGING
- (1) CONTAINER, WATER 20 LIT
- (2) FIGURE EIGHT DESCENDERS
- (1) FIRE EXTINGUISHER
- (2) FIRST AID KITS
- (10) GLOVES, DEBRIS, HEAVY LEATHER, NO STUDS
- (1) GLOVES, RUBBER INSULATION
- (10) GOGGLES, DUST
- (2) HAMMERS, CLAW
- (3) HAMMERS, CLUB
- (2) HAMMERS, SLEDGE 3KG
- (2) HARNESES, SIT
- (2) HARNESES, LINESMAN, WAIST
- (2) HATCHETS, CASE OPENING
- (1) HYDRAULIC RESCUE KIT WITH OR WITHOUT SHEARS
- (1) JACK, MECHANICAL 6 TONNE
- (2) KARABINERS STEEL, SCREWGATE, LARGE
- (8) KNIFE CLASP
- (1) LADDER, 2.5m - 4.0m EXTENSION
- (1) LADDER, 5m - 9m EXTENSION
- (1) LADDER, WIRE GALVANISED, 15m
- (2) LAMPS, HAZARD WARNING, BATTERY POWERED
- (4) LIGHTING, GROUND AND ELEVATED, 240VAC 500 W or 150W
- (1) LOUD HAILER
- (6) MARKER PANELS, GROUND/AIR - AS REQUIRED (HAS SIDE LOOPS  
FOR USE AS EMERGENCY STRETCHER)
- (3) MATTOCKS, CROSS GRUBBING
- (2) PLIERS, SIDE CUTTING, INSULATED
- (3) POLES, DERRICK 6m x 7mm WITH BUTT, MIN 100mm
- (1) PUMP, STIRRUP/KNAPSACK SPRAY

A-4

- (10) ROPES, 12m x 12mm, MANILA
- (6) ROPES, 12m x 16mm, MANILA
- (1) ROPE, 125m x 16mm, MANILA
- (2) ROPES, 125m x 24mm, MANILA
- (2) ROPES, 50m x 11mm, BLUE WATER 2 STATIC
- (1) ROPE, 100m x 16mm, BLUE WATER SUPERLINE STATIC
- (2) ROPES, WIRE, 16mm x 15m
- (1) ROPING DEVICE, SELF OPERATED, 60m - 250m ROPE  
(ROLLGLISS OR SIMILAR)
- (1) SAW, HAND
- (1) SAW, BUSHMANS 900mm
- (1) SAW, CROSS CUT
- (1) SAW, CHAIN WITH 500mm-600mm BAR
- (2) SAWS, GENERAL PURPOSE
- (2) SAWS, HACK
- (1) SAW, CUTQUICK, METAL AND CONCRETE
- (2) SHACKLES, "D" TYPE, TESTED 2 TONNES
- (1) SHEETING, POLYETHYLENE, 4m WIDE x 200um THICK IN 50m  
ROLLS
- (4) SHOVELS
- (2) SLINGS, WIRE, 3m x 13mm, SWL 1.5t, SUPERFLEX
- (1) SPANNER, CRESCENT 380mm
- (2) SCREWDRIVERS, 230mm
- (6) STRETCHERS, FOLDING
- (1) STRETCHER, BASKET TYPE WITH 4 POINT BRIDLE
- (4) TARPULINS, 3.6 x 3.6m, HIGH DENSITY POLYETHYLENE
- (1) TARPULIN, 9m x 6m, HIGH DENSITY POLYETHYLENE
- (1) TAPE, MEASURING x 2m
- (1) TIRFOR, HAULING AND LIFTING COMPLETE, 1.5 TONNE
- (8) TORCHES, HAND HELD



## CHAPTER 2

### ROPES, CHAINS AND SLINGS

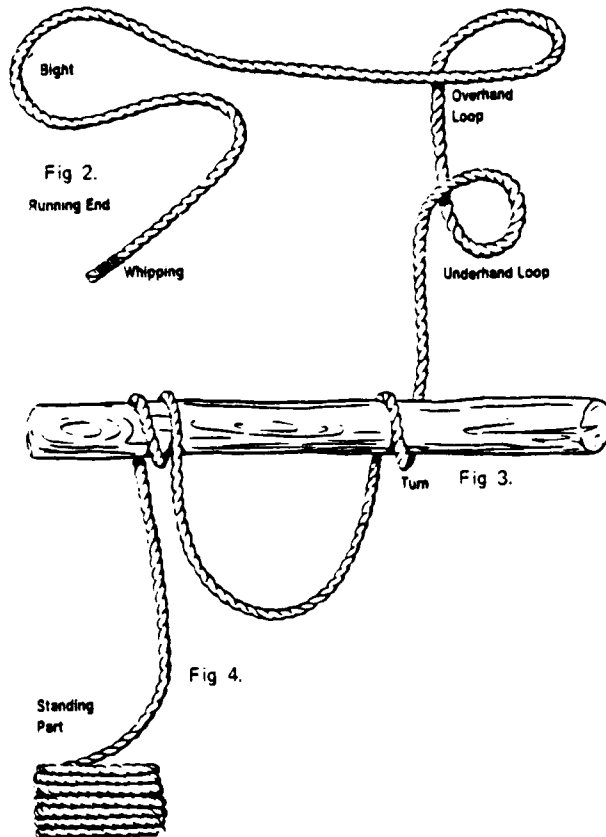
2.0 Rope is one of the most important tools of the rescue unit. Members will use Steel Wire Rope, Natural Fibre Rope and in some cases Synthetic Fibre Rope - all types have their uses and their weaknesses, but provided the rescue member has a thorough knowledge of the Safe Working Load (SWL), of each rope and the care and maintenance required, all types can give extended periods of valuable service.

#### 2.1 Terminology

The following is standard Rope and Knot terminology.

<u>Anchored</u>	Fastened to some immovable object
<u>Bight</u>	An open circle in a rope - also refers to the middle part of a length of rope (Fig. 2)
<u>Breaking Strain</u>	See "Mean Breaking Load"
<u>Frapping</u>	The binding together of a lashing between two poles
<u>Haul</u>	The act of pulling on a rope
<u>Hitch</u>	A closed loop on a rope; a simple fastening of a rope around some object by winding and crossing one turn so that one bites on the other without actually knotting the rope.
<u>Marrying</u>	Twisting the running end around the standing part, in the same direction as the lay of the rope.
<u>Mean Breaking Load</u>	The averaged ultimate breaking point of rope. Expressed in kilograms (kg) or kilo-newtons (kN) following rigorous testing.
<u>Mousing</u>	Tying a piece of cord or wire across the jaws of a hook to prevent a rope or sling from jumping out.
<u>Parcelled</u>	When part of a rope is wrapped to prevent chaffing.
<u>Paying out or Easing</u>	To ease off or slacken a rope.
<u>Reeve</u>	The threading of a rope through pulley blocks or snatch blocks.
<u>Round Turn</u>	One complete turn of a rope round a spar or another rope. (Fig. 3)

<u>Running End</u>	The free end of a rope. (Fig. 2)
<u>Safe Working Load (SWL)</u>	The load which can SAFELY be applied to a rope. (See para 2.4 for calculation)
<u>Standing Part</u>	The part of a rope which is taking the load. (Fig. 4)
<u>Whipping</u>	Binding the end of a rope with twine to prevent untwisting or fraying. Figure 5 illustrates one method of whipping. Other methods including mechanical means are available.



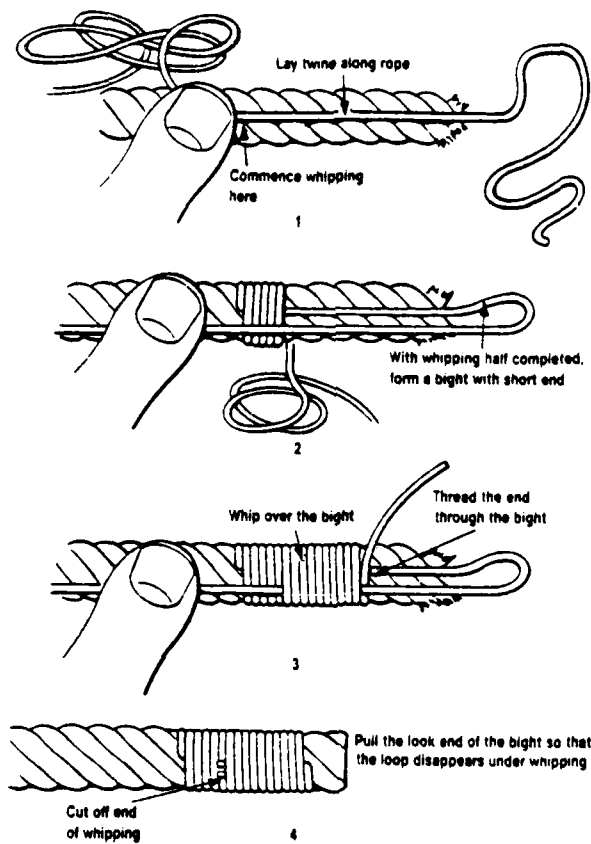


Fig 5.  
Basic Whipping

## NATURAL FIBRE ROPES

### 2.2 Material

Ropes may be made from a variety of materials some of which are Manila, Sisal, Coir, Hemp, Cotton, Jute, or Flax. The harder fibres are Manila, Sisal and Coir while the remainder are soft fibres. Manila and Sisal are the only two materials used in the manufacture of natural fibre ropes for rescue lines with Manila, in recent years, being preferable to Sisal. Some of the softer fibres are used in the manufacture of sash cords which are ancillary ropes used in rescue work. The comparison of Manila and Sisal Fibres are shown:

- a. Sisal has a harsher fibre and therefore makes a stiffer rope.
- b. New Sisal is white in colour while Manila is light brown.
- c. Both ropes are similar in weight.
- d. Both ropes have a similar safe working load.
- e. Sisal absorbs moisture more readily than Manila and deteriorates more rapidly. It therefore requires more frequent inspection.

### 2.3 Construction (Figure 6)

Most cordage is constructed by taking a number of threads or fibres and twisting them into yarns. The yarns are then twisted to make strands and the strands (generally three in number) are laid together to make the finished rope. The number of fibres in the yarns and the number of yarns determine the size of the rope. This type of rope can be either left hand lay or right hand lay and is termed "Plain or Hawser" laid rope. It has been accepted generally for natural fibre rescue lines.

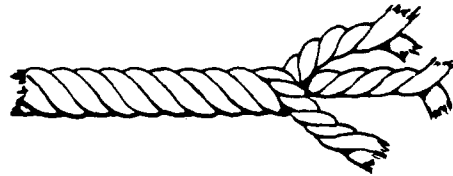


Fig 6.

2.4

Safe Working Loads

Both Manila and Sisal ropes have a stated manufacturers "Mean Breaking Load" (MBL) which is determined by testing the rope to specifications laid down by Australian Standard 1504. The "Safe Working Load (SWL)" is determined by dividing the MBL by a Safety Factor (SF) of 7 for rescue purposes. This gives the Safe Working Load for a new rope.

eg:

ROPE SIZE	MBL	SF	SWL (APPROX)
12mm Manila	930kg	7	133kg
16mm Manila	1800kg	7	257kg
24mm Manila	3980kg	7	568kg

A good field rule of thumb method of determining the SWL of new Manila or Sisal is as follows:

Square the rope diameter in millimetres, the answer is the SWL in kilograms per single fall or part.

ie:  $D^2_{mm} = SWL (kg)$

eg:

ROPE SIZE	SQUARE DIAMETER		SAFE WORKING LOAD
12mm	12x12	=	144kg
16mm	16x16	=	256kg
24mm	24x24	=	576kg

These calculations are for new unused rope.

After natural fibre rope has been used, it is classed as previously used rope and the following calculations apply.

The SWL of previously used rope is 2/3 the value of new rope.

EXAMPLE A new 12mm diameter Manila rope can support 144kg safely. Previously used 12mm Manila rope would only support (2/3 of 144kg) = 96kgs safely.

When tying a knot or knots in a rope or tying around a circular object, a further reduction to 2/3 of the safe working load will apply.

EXAMPLE When using a previously used rope around a circular object with a knot or knots in the rope, the calculations for a 12mm rope to support a load safely would be:

New Rope value =  $12 \times 12 = 144\text{kg}$   
Previously Used =  $144 \times 2/3 = 96\text{kg}$   
Knots & Circular bend =  $96 \times 2/3 = 64\text{kg}$

Should a turn have to be taken around a square object or over a sharp edge, a value of one half ( $1/2$ ) would be used as the deduction instead of  $2/3$ , however, sharp edges should be padded or rounded if at all possible, to eliminate this additional deduction.

The following safety points MUST be adhered to when estimating the safe working loads of any rope:

- a. Do not use fibre ropes of less than 12mm diameter for any rescue purpose.
- b. Fibre rope held by hand for load hauling or life support purposes, should not be less than 16mm in diameter.
- c. Ropes must be carefully inspected following any use and prior to return to the vehicle or store.

## 2.5 Inspection (laid ropes)

It is essential to have sufficient space to handle the full length of the rope in systematic fashion and to have good light.

The entire length of the rope should be inspected in sections of approximately 300mm at a time by slightly twisting against the lay to expose the inner surfaces of the strands for inspection. Return the strands to their original position afterwards. The outer layers of the strands must also be carefully inspected.

When examining, check for the following externally:

- a. Broken fibres - abrasions.
- b. Cuts.
- c. Soft Spots - a sure sign of wear.
- d. Decay or burns - heat or chemical.
- e. Cutting in or drawing down on one strand.

Check the Interior of the rope for the following:

- a. Broken fibres.
- b. Powdering internally - indicating grit or overloading.

- c. Dry rot or mildew.
- d. Change in colour.
- e. An odour indicating mildew, rot etc.

Rope which has been inspected should be tagged indicating the name of the inspecting officer and the date on which it was inspected.

2.6

Care and Maintenance

- a. Avoid cutting a rope unless it is essential to do so. If it is necessary, ensure the cut end is whipped as soon as possible to prevent fraying. (As a temporary measure, tie a figure eight knot near the end of the rope. Adhesive tape is also useful as a quick temporary whipping).
- b. Avoid permanent knots in a rope as they considerably reduce its strength by seriously damaging the fibres.
- c. Avoid, as far as possible, dragging ropes over rough or sharp surfaces.
- d. Always use proven knots and fastenings for ropes. Sharp bends or knots can cause some strands to become overloaded.
- e. Use the correct size sheave in pulley blocks. Any attempt to force a thick rope through a smaller block will cause damage.
- f. Avoid sudden jerks or violent stress on the rope.
- g. Avoid passing a rope over a sharp edge. If it is necessary to do this, protect the rope with sacking or a piece of rounded timber.
- h. Ropes which have been hauled through mud, sand or grit should always be cleaned after the work has been completed by thoroughly washing the rope with fresh running water.
- i. Do not dry ropes in front of a fire. Spread on a ladder, laid horizontally off the ground, will enable the air to circulate freely around the rope.
- j. Store fibre ropes under cover, off the floor, preferably on racks in a place free from the extremes of temperature and out of contact with materials containing any acid or strong alkali eg, Creosote.
- k. Try to keep the area free from rodents.

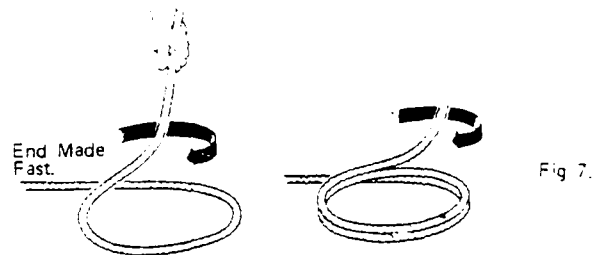
- l. If a coiled rope has to be stored in an exposed location, cover it with a tarpaulin or some other form of protection.
- m. Report defective material as soon as possible.
- n. Inspect quality of whipping and repair when necessary.

#### COILING NATURAL FIBRE ROPES

- 2.7 It is important that rescue personnel standardise on a set pattern for coiling ropes, be they 12m lashings or 125m coils.

- a. Long Lengths 16mm and 24mm Rope. (Figure 7)

Coil the rope in a clockwise direction because of the natural twist of the rope, in coils of approximately 1.5 diameter. If the rope twists or kinks when coiled, it is because it has been given a reverse twist while in use. To remove this, coil it counter clockwise. The coil is then frapped at one end with the free end of the rope.



- b. 12 Metre Lashings. (Figure 8)

The rope should be wound around the elbow and hand until about 1m of rope remains. This is then frapped around the centre of the flattened coil.

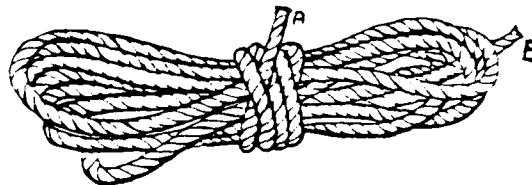


Fig 8.



There are many occasions where the task is made easier by leaving the lashing coiled and pulling end B.

## SYNTHETIC FIBRE ROPES

### 2.8 Materials

The main synthetic fibres used in Australia at present are listed below:

- a. Polyamide - also known as Nylon or Perlon.
- b. Polyester - also known under the trade names of Terylene, Dacron and Tetoran.
- c. Polyvinyl - Alcohol - also known as Vinyon or Vinylal and under the trade names of Kuralon, Meulon etc.
- d. Polyethylene - also known under the trade names of Courlene, Tanikalon, Polythene, Drylene and Silver Rope.
- e. Polypropylene - also known under the trade name of Ulstron.

NOTE: This section will deal only with Synthetic Fibre Ropes of the Polyamide and Polyester types, these being the only satisfactory materials for the construction of rescue lines. These ropes exhibit high qualities of strength, resistance to abrasion, knottability, flexibility and handling with either high or low elongation, depending on the variety selected.

### 2.9 Rope Forms

Synthetic ropes are manufactured in several different forms. These may be defined as:

- a. Multifilament: Multifilament ropes are composed of a number of very fine filaments twisted together, each filament being continuous throughout the yarn length.
- b. Staple: A staple rope is one made up of many individual short fibres which vary in length, and this length is determined by the processing machinery on which it is used. The staple length can vary from 40mm to 1500mm.
- c. Fibre Film: A plastic type material capable of being extruded in flat sheet form which is then split, drawn and cooled. The tape is produced in extreme lengths (normally the full length of the rope) and a twisting operation is required to convert it into a yarn.

2.10 Construction

Rope is commonly available in four distinct constructions: 3 strand hawser laid, braided sheath, braided yarn or plaited yarn. This section will only deal with 3 strand hawser laid and braided sheath type construction. In the manufacture of multifilament, and fibre film rope, the filaments can be used as yarns and twisted together to make strands. The strands can then be twisted clockwise to make a completed rope as in the plain or hawser laid rope or alternatively laid together and encased in a plaited sheath. One such rope of the multifilament, core and sheath type is the 11mm Blue Water 2 rope which is made of Nylon or Polyamide material. This rope has a limited stretch factor and is ideally suited for use with mechanical descent and ascent devices.

Core and sheath ropes are commonly referred to by the German term Kernmantel.

2.11 Safe Working Loads

In most cases, synthetic fibre ropes are stronger than their natural fibre counterparts, but it is important that ropes be identified correctly because in the cases of Polyethylene and Polyvinyl Alcohol ropes, the Safe Working Loads are only marginally superior to Manila, while the melting point of Polypropylene and Polyethylene are sufficiently low, to be seriously affected by the heat generated in a mechanical descent device and should not be used in this manner. The safe working load of Polyamide and Polyester ropes can be calculated as follows:

$$\frac{\text{Mean Breaking Load (kg)}}{7} = \text{SWL (kg)}$$

In general terms, Polyamide dynamic (climbing) ropes should always be used where elongation under stress for shock absorption is required, and Polyamide 'static' ropes such as Blue Water 2 or Polyester ropes should be used where high strength and low stretch are called for.

The deductions as calculated for natural fibre rope relating to previously used rope, knots and sharp edges are the same when using natural or synthetic fibre ropes.

2.12 Inspection

Synthetic ropes, under normal conditions may dull the user into a false sense of security, making their failure unexpected and dangerous. The fact that some synthetic ropes may be inherently stronger than the equivalent size natural fibre ropes, must not be allowed to influence the user that normal safe working

practises can be reduced or ignored. Any diminution of safety precautions or procedures can lead to an unexpected and potentially dangerous failure.

Synthetic Fibre Ropes must be regularly inspected

Have sufficient room and light to enable the inspection to be carried out correctly by checking the following:

- a. Inspect the full length at intervals of approximately 300mm.
- b. If hawser laid, the line should be slightly untwisted locally to reveal the inner surface of the strands, care being taken to return the strands to their original position.
- c. If the rope is of the braided sheath type, inspect excessive wear of the sheath, cuts or tears. An additional check should be made for unnatural stiffness which might indicate overstretch.
- d. Check for permanent stretch. The resistance of synthetic ropes to damage due to repeated overloading is good, but a permanent elongation may occur locally. A visible reduction in the cross section may occur and should be looked for.
- e. Bleaching of a synthetic rope is generally caused by the rope being placed in direct sunlight for prolonged periods. The outer fibres become affected by ultra violet rays and the problem is obvious by the fading of the finishes or dyes.
- f. Fusion caused by heat or chemicals: any sign of this warrants immediate rejection. While Polyamide material is not affected by alkalis and Polyester is resistant to the effects of acids, all synthetic fibre rope should be kept free of contamination by any chemical substances.
- g. Hardening of fibres. After considerable use with mechanical descent devices, a general stiffening of fibres is sometimes apparent and usually accompanied by heavy "fuzzing" of the braided sheath. Where the stiffening of the fibres becomes more pronounced and the rope does not become more pliable when relaxed, or when the abrasion 'fuzz' exceeds 25% of the original rope diameter, the rope should be removed from service.

2.13

Care and Maintenance

- a. Because they stretch, synthetic ropes will fly back on parting, therefore it is imperative that no one stands in the direct line of pull when a heavy load is applied to a rope.

- b. Do not use a single part of a hawser laid rope for hoisting or hauling any load that is free to rotate.
- c. Avoid sudden release of tension on a rope. This could cause kinking which is a localised distortion of a strand by a back twist.
- d. Avoid dragging ropes through mud and sand. Ropes contaminated should be washed clean with water and dried before storing. Sand, particularly when wet adheres to rope and works into the inner fibres and cuts them by abrasion.
- e. When it is necessary to tie a knot in a rope, use only knots which have been proven and accepted.
- f. Never leave knots in a rope that is to be stored.
- g. Always store in a cool dry place where air can circulate freely.
- h. Store ropes out of direct sunlight and away from heat and chemicals.
- i. Carefully inspect ropes following use and prior to return to vehicles or stores.

STEEL WIRE ROPE (SWR) (Figure 9)

2.14 Steel wire rope consists of a number of strands (usually six) with a fibre core. Each strand consists of a number of steel wires - the most common form of construction being 6/19 indicating six strands of nineteen steel wires with a fibre core. (Fig 9). During manufacture, wires and strands are either coated with lubricant to prevent corrosion and friction in the rope, or are galvanised. The size of Steel Wire Ropes (SWR) is measured by its diameter (D) in millimetres. Once again a rule of thumb method for calculating Safe Working Loads is given for use in the field in the absence of any manufacturers specifications.

$$D \text{ mm} \times 8 = \text{SWL in kg}$$

eg. New 14mm Steel Wire Rope

$$14 \times 14 \times 8 = 1568 \text{ kg}$$

If a Steel Wire Rope is sharply bent, the Safe Working Load must be reduced by 30%.

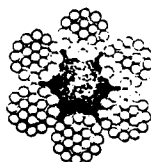


Fig 9.

6 x 19

2.15 Care in Use

Wire ropes should not be bent sharply at any point. As a general rule the smallest diameter around which a wire rope is to be bent should be approximately six times the circumference of the rope - anything smaller than this will set up undue strain on the steel wires.

2.16 Inspection of Wire Ropes

- a. Check the shackle used with the rope to see that it has not suffered distortion or strain and that the shackle pin is in good condition, easily screwed home by hand.
- b. Examine the thimble and splice. The splicing cannot be seen as it is covered by the wire binding or 'serving', but if the binding is loose or shows signs of bulging, it is probable that the splice is starting to come undone.
- c. Working along the rope a hand's breadth at a time, see that it is reasonably round, ie. it has not been flattened in use or suffered distortion which causes the wires to open and thus weaken the rope.
- d. Look for broken wires. A broken wire in a rope should always receive prompt attention. Delay may lead to serious accidents and will certainly cause damage to other wires. The method often used to deal with a broken wire, (by nipping it off with pliers) is by no means the best way, for this leaves a small jagged end. To save time and trouble, simply bend the wire backwards and forwards with the fingers until it breaks, or, in the case of a short end, use a piece of wood. In this way, the wire breaks inside instead of outside the rope, and the end is left tucked away between the strands where it can do no harm.
- e. Look for kinks. When a rope has been kinked, the kink may pull out when the wire is stressed and although the rope appears reasonably sound, the structure of the rope has been distorted and damaged. The length affected by the kinking may only be small, but this becomes the weakest part of the rope. The presence of a kink in a rope is best detected when the rope is lying slack on the ground. Rope of any sort found defective should be labelled and placed apart from good ropes until it can be examined by a competent person.

2.17 Storage of Wire Ropes

Wire ropes should be stored under cover in a clean dry place and in such a manner that no part touches the ground. They must never be stored by laying on concrete, ash, clinker, or coke breeze floors as these materials have an adverse affect on steel. Periodical inspection for corrosion is necessary.

2.18 Records

The results of all inspection, including details of any damage found should be recorded in a Register of Chains, Ropes and Lifting Tackle. Any equipment assessed as unserviceable should be retired from service and discarded.

CHAINS AND SLINGS

2.19 General Precautions in Use of Slings

The method of slinging any given object must vary according to circumstances, but certain general rules and precautions should be observed to ensure safe working.

- a. The size and therefore the safe working load of the sling will be governed by the weight of the load.
- b. Timber packing must be inserted between the sling and the edges of the load to prevent the sling coming in contact with sharp edges.
- c. Hooks must be moused.
- d. Wire rope slings must not be bent around too sharp an angle and to prevent this, packing may be necessary.
- e. Carelessness in hoisting, eg. shock lifting, snatching must be avoided.
- f. Slings should not be dragged along the floor or ground and should never be pulled from under a load which, when lowered, is resting on the sling.

2.20 Chain Slings (Figure 10)

Most chain slings supplied are the single leg type with a hook at one end and a ring at the other. In all reputable brand chains, the Safe Working Load is stamped on a tag connected to the ring end of the chain. This figure should be referred to before any slinging is undertaken. Should the information on Safe Working Loads not be available the following is an APPROXIMATE rule of thumb method:

$$W = \frac{D^2 \times 100}{13}$$

Where W = SWL in kilograms

D = Diameter in millimetres of the smallest link

eg. 12mm chain

$$\frac{12 \times 12 \times 100}{13} = 1107 \text{ kg SWL}$$

This is a Safe Working Load for a single leg vertical lift. A common misconception with slinging is that if the number of legs in the sling is increased, the safe working load is the safe load on one leg multiplied by the number of legs in use. This is only true when all legs are in the vertical position. The following formula indicates the increase in tension on multiple sling legs.

T = Tension in Rope or Chain in each sloping leg

L = Length of each leg

R = Rise

W = The load to be lifted

$$T = \frac{1/2 W \times L}{R}$$

ie. If W is a load of 2 tonnes

L is a length of 700mm

& R is a distance of 300mm

$$\text{then } T = \frac{1/2 \times 2.0 \times 700}{300} = 2.333 \text{ tonnes}$$

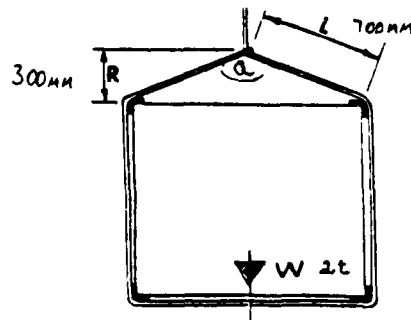


Fig 10.

Therefore the tension in each leg exceeds the original load weight.

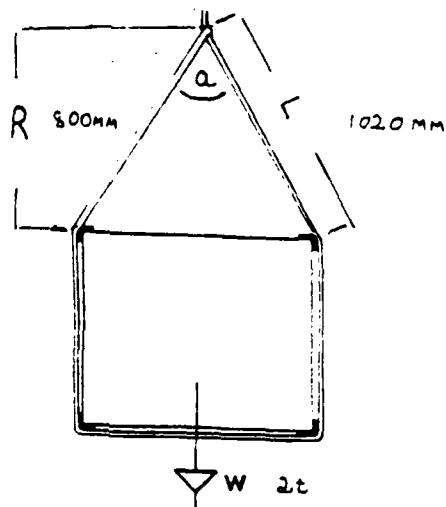
It can be seen that the longer the rise ie, the smaller the angle (a), the less tension on the sling legs.

eg. W is the same load of 2 tonnes  
L is a length of 1020 mm  
R is a rise of 800mm

$$\text{then } T = \frac{1/2 \times 2 \times 1020}{800}$$

= 1.28 tonnes in each leg (Fig 11)

Fig 11.



## 2.21 To lift a Load With a Chain Sling

- a. The ring of the sling can be placed on the hook of the lifting tackle and the sling hook placed in the ring; or
- b. The ring of the sling can be placed on the hook of the lifting tackle and the sling hook placed around the chain after passing the chain around the article to be slung.

Chain slings should never be shortened by tying a knot in the chain, as this will cause excessive bending stresses in some of the links and may result in damage or fracture.



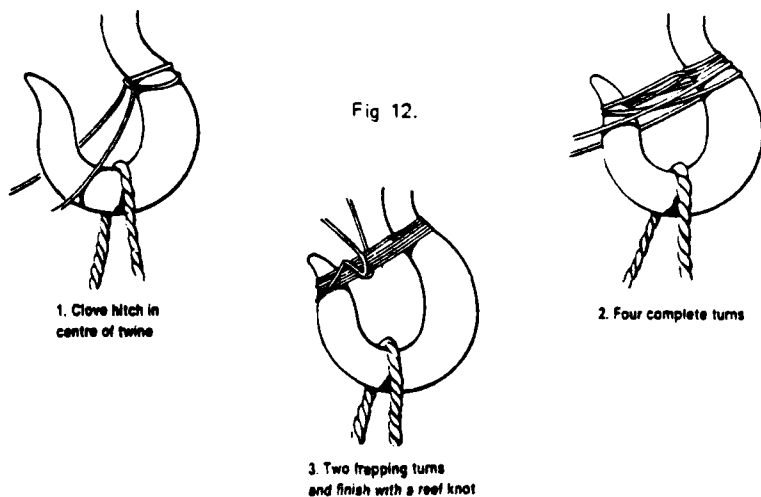
## 2.22 Wire Rope Slings and Natural Fibre Rope Slings

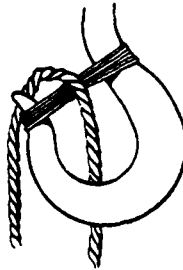
It may at times be necessary to improvise by using the issued 16mm SWR supplied, or Natural Fibre Rope. The calculations for Safe Working Load for Steel Wire Rope and Multiple Sling Legs and Natural Fibre Rope still apply as do the general precautions previously detailed.

## HOOK MOUSING

2.23 Two methods of mousing a hook are currently used. The "Standard" method used over the years (Fig. 12), has an inherent problem in cases where a sling is attached to a hook which may be moved so as to cause displacement, the gear or block may become inadvertently twisted so that the sling engages the mousing instead of the hook (Fig 13). Therefore care must be taken when using this method. In cases where two or more eyes of slings are engaged by a hook, it is difficult but not impossible to lash the eyes into the cup of the hook so that they cannot be displaced accidentally. Figure 14 shows one method. The lashing cordage is used on the bight for speed of application and strength. It is first hitched to the hook above the bulge of the shank so that it cannot be pulled downward, then led towards the cup of the hook, being fixed to the shank again by one or more half hitches prior to the formation of the first figure of eight or diagonal lashing turns which are passed around the hook on alternate sides of the sling eyes. At least 2 half hitches are passed around the diagonal turns and inside the eyes of the slings to prevent the bights of the diagonal turns from sliding over the bill.

### STANDARD METHOD





When weight is released  
sling can jump across  
mousing

Fig 13.

#### ALTERNATIVE METHOD

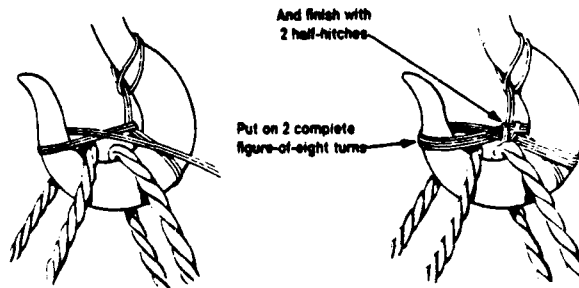


Fig 14.

## KNOTS

- 2.24 Rescue personnel should be familiar with the following knots and by constant practice learn how to make and adapt them with speed and proficiency. Knots must always be tied tightly, dressed down and inspected. Remember, a knot that does not look right almost certainly is incorrectly tied.

2.25 Thumb Knot (Figure 15)

This is a simple knot tied in the end of a rope to stop a rope passing through a pulley or temporarily to prevent fraying of an end. The knot is formed by making a loop and passing one end through it.

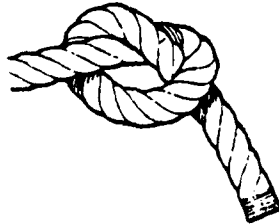


Fig 15.

2.25 Figure of Eight Knot (Figure 16)

With the rope away from you, take the standing part in the left hand palm upwards and the running part in the right hand. Pass the running end over the top of the standing part making a loop, then carry on with the running end round behind the standing part, over the top then down through the loop which you have formed. Draw the running end tight and the knot should resemble the figure eight. This knot is useful as a stop and is often used to prevent the end of a rope from running through a block. It can also be used to prevent fraying when the whipping has been lost. In general it is more useful than the thumb knot as it is easier to undo.

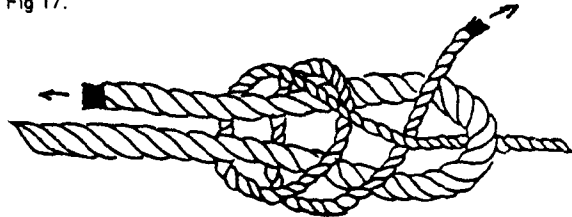


Fig 16.

2.27 Double Sheet Bend (Figure 17)

This bend is used for joining ropes, regardless of size. It is made by forming a loop in the thicker of the two ropes and holding this in the left hand. Pass the running end of the other rope up through the loop and around both thicknesses of the thicker rope twice and then under its own standing part without overriding, so that the running ends of both ropes pass out of the knot on the same side.

Fig 17.



2.28 Reef Knot (Figure 18)

A good general purpose knot, very useful in first aid and tying parcels etc. It is formed using two running ends and the formula right over left, tuck in left over right, tuck in should be always used to avoid tying a granny knot. Reef knots are easily untied by pulling one running end and standing part on the same side. For this reason it is not good practice to join ropes with a reef knot - better a double sheet bend.

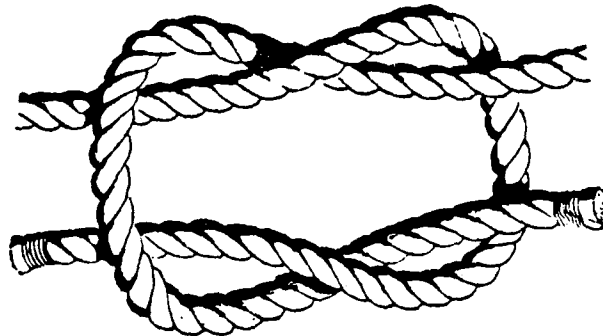


Fig 18.

2.29 Fishermans Bend (Figure 19)

This knot is used when anchoring synthetic lines and is a variation of the round turn and two half hitches to give greater security for synthetic descent lines. Take a round turn around the anchor point, bringing the running end out under the standing part. Feed the running end through the two round turns from the top and finish off with two or more half hitches around the standing part.

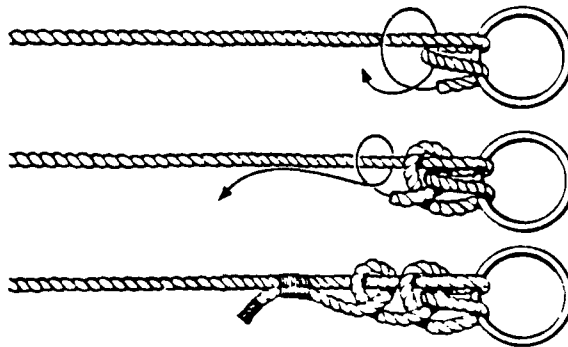


Fig 19.

2.30 Double Fishermans Knot (Figure 20)

This knot is the preferred method of joining synthetic lines and can be used to join together synthetic or natural fibre lines of equal or unequal sizes. It will, with care, pass through a figure eight descender. Lay both ropes side by side in opposite directions. Make two round turns to the left with the right hand running part and feed the end under the two round turns. Make two round turns to the right with the left hand running end and feed the end through the two rounds turns. Dress and pull tight.

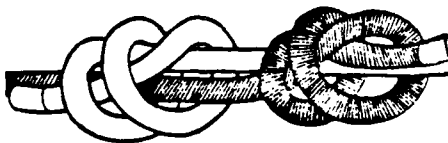


Fig 20.

2.31 Half Hitch (Figure 21)

This is formed by passing the short end of a rope around the spare (or around another rope) and under the standing part, so that, when pulled, one part of the rope binds the other.

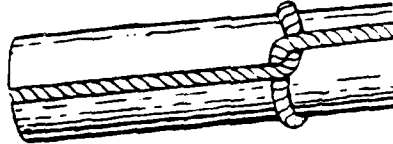


Fig 21.

2.32 Clove Hitch (Figure 22)

This forms the basis of many securing knots and is useful for hoisting timbers and rescue tools and fastening a rope onto another rope at right angles. It can be used in the centre or end of a rope. To tie at the end of a rope (Fig 22A), pass the running end over a pole bringing it out underneath the standing part. Pass the running end round the pole again above the first half hitch, bringing the running end under itself to tighten, pulling both the running end and standing part. When tied thus in the end of a rope, it is a good anchoring knot which is easily untied. To tie in the centre of a rope (Fig 22B) two loops are formed, one in the left hand (anti clockwise) and one in the right hand (anti clockwise) the latter being passed in front of the left hand loop. Both loops are then passed over the pole and drawn tight.



CLOVE HITCH



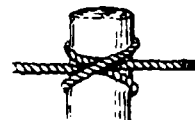
Underhand loop



Add second loop



Lay one loop over the other



Place over timber

Fig 22A.

Fig 22B.

2.33      Round Turn and Two Half Hitches      (Figure 23)

This is also used for securing the running end of a rope to a spar or ring and is formed by a round turn on the spar or ring with two half hitches on the standing part of the rope. It has the great advantage of allowing a load to be adjusted using the round turn, then finally secured by using the two half hitches on the standing part of the rope.

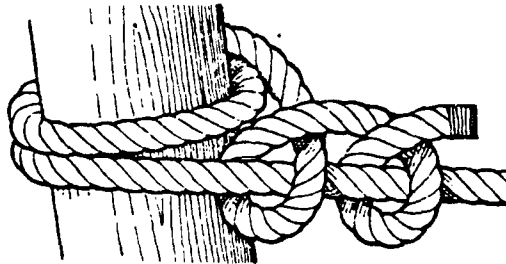


Fig 23.

2.34      Timber Hitch      (Figure 24)

This is a quickly made hitch used to secure a rope to a plank or pole and is formed by making a half hitch on the standing part of the rope, leaving a long end which is twisted with the lay for a minimum of 3 turns around its own part of the hitch. When used for lifting spars, planks or poles, this hitch should be used in conjunction with a half hitch at the upper end of the spar.

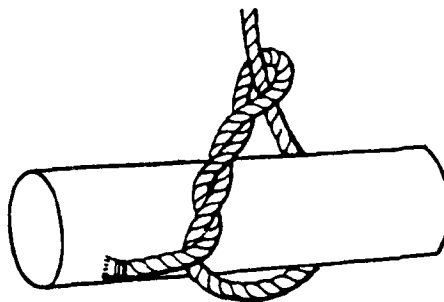


Fig 24.

2.35 Figure of Eight Loop/Figure of Eight on the Bight

This knot produces a non slip loop which is easy to undo but a little more time consuming to tie than the bowline. It is however, a bend rather than a knot and thus has a lower percentage deduction from the Safe Working Load (SWL) than the bowline. Tie a single figure of eight knot as described previously. Take the running end and pass it around the object ie, pole or your body. Take the running end and follow exactly the path back that the running part took when forming the original figure eight. Dress the bend and tighten. (Figure 25A).

An alternative method where a free loop is required at the rope end, is to double the end of the rope for about 500mm. This doubled rope is tied off in the same manner as the Figure 8 Knot (Figure 25B) and forms a locked bight. This knot is known as the Figure of 8 on the Bight.

Fig 25A.

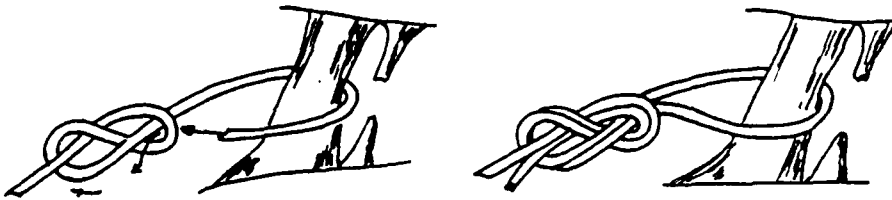


Fig 25B.



2.36 Bowline (Figure 26)

The bowline is one of the most used knots in rescue work. It produces a non-slip loop which is always easy to undo, even though the rope is wet. The bowline is used extensively in making a life line around a person's waist and also for securing guide lines to stretchers. Hold the rope in the left hand and form a small loop over the top of the standing part. Hold in place with the thumb on the left hand. Then with the running end (around the back if necessary) feed the end through the back of the loop, round behind the standing part and tuck the end back through the loop. Dress and pull tight. Time should be spent practicing tying the bowline around objects, around the waist and with an open loop.



Fig 26.

2.37 Bowline on the Bight (Figure 27)

If you need a secure loop a bowline or a double figure of eight is used, but if a double loop is required a Bowline on the Bight is a useful knot. It can be used for hauling or lowering a man up or down a vertical face, either with one leg through each loop and holding the standing part, or with one loop around the hips the other under the arms. It can also be used in raising or lowering a stretcher or ladder horizontally. To tie, double the end up the standing part to make a good long bight and take the doubled rope in your left hand. Using the double rope, form a loop at the top as in the ordinary bowline and feed the main bight up through the loop from behind until you have as much of the bight above the loop as below it. Take hold of the upper bight and bring it down, over and behind the lower loop. This produces two lower loops. (Figure 27). Holding the knot in place, pull on the loops until the knot is tight. This knot has to be dressed and shaped to the function for which it is going to be used.

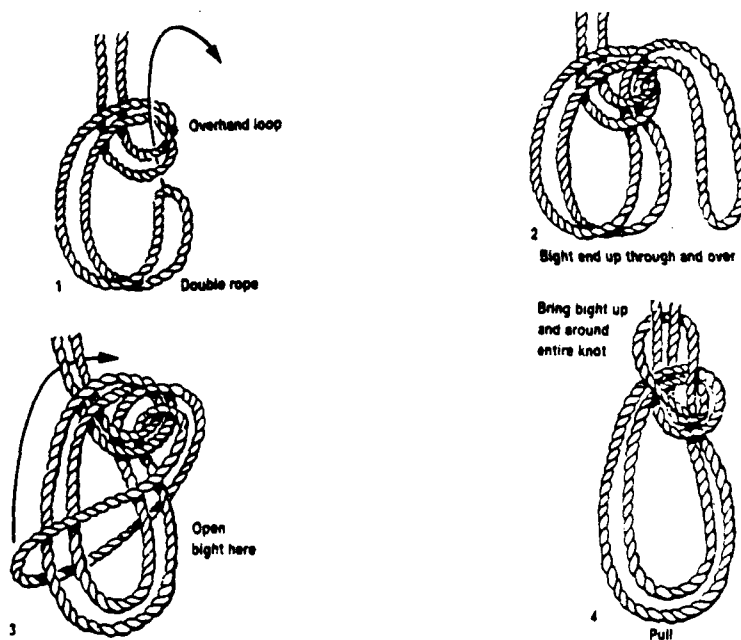


Fig 27.

## 2.38

### Chair Knot

The chair knot is very important for emergency rescue work. One of its main purposes is to form an efficient and quickly made sling in which a person may readily be raised or lowered. The sling formed by this knot gives support to the chest and legs of the person being rescued. It is formed by grasping the rope, near its centre, in the left hand, palm down. Approximately a metre from the left hand take the rope in the right hand, palm uppermost. Turn the left-hand palm upwards forming a loop (anti-clockwise), turn the right-hand palm down forming a loop. Pass the standing ropes through the loops of the opposite hand pulling them through, thus forming two loops with a knot in the centre. These loops are then adjusted to the required size and a half hitch is then made on each loop to lock them at their required size. (Figure 28) Initially, loops should be of equal size (knot placed in the centre of the chest and arms extended). The casualty is then slung, one loop under his arms and one under his knees. The knot should be midway between his nose and knees. The chair knot may also be used as a stretcher sling, made by forming a chair knot complete

with half hitches, in the centre of a 12 metre lashing. The sling is attached to the stretcher handles by means of half hitches and adjusted. The main lowering or lifting line is normally attached to the chair knot by making a round turn and two half hitches through the long legs of the knot.

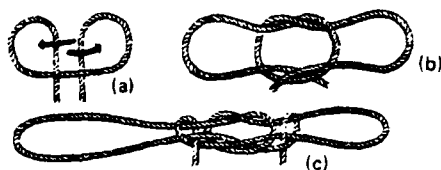


Fig 28.

2.39

#### Portugese Bowline

While the Chair Knot has traditionally been used as an emergency casualty sling or stretcher sling, it is not a strong knot, and the Portugese Bowline is preferred for strength and simplicity. Two (or more) loops are formed at the rope end, and the running end of rope is taken up through the cuckolds neck, around the standing part and back down through the cuckolds neck in the same manner as the standard Bowline (Figure 29). This knot is also known as the French Bowline.

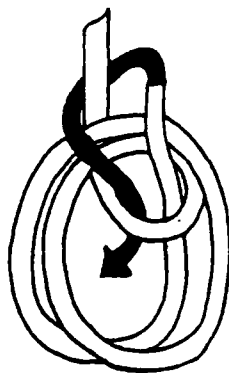


Fig 29.

#### 2.40 Knot Safety

The following major points should be observed:

- (a) Any knot tied at or near the end of a synthetic rope must be protected with an Overhead Knot tied on the inactive side of the main knot to prevent knot slippage (Figure 30).



Fig 30.

- (b) Knots must be tied with a minimum tail of 75mm protruding from the knot.
- (c) All knots must be monitored and checked throughout any operation.
- (d) Knots must not be left permanently in rope as they will deform the rope fibres and weaken the rope.

#### 2.41 Knot Strengths

The following chart shows the approximate residual breaking strains of new rope in which rescue knots have been tied:

Thumb (Overhand) Knot	45-55%
Figure of 8 Knot	55-65%
Double Sheet Bend	55-65%
Reef Knot	55-60%
Fishermans Bend	60-65%
Double Fisherman Knot	60-70%
Half Hitch	-
Clove Hitch	60-70%
Round Turn & Two Half Hitches	60-65%
Timber Hitch	60-70%
Figure of 8 Loop	60-70%
Figure of 8 on The Bight	60-70%
Bowline	60-65%
Bowline on the Bight	60-65%
Chair Knot	40-45%
Portugese Bowline	60-65%

### LASHINGS

2.42 Lashings are used mainly to secure two or more poles firmly together. The form of each type can best be understood by a careful study of the diagrams and appended explanations.

2.43 Terminology

All poles or timbers used in a vertical attitude or which will be raised vertically are referred to as STANDARDS, while those used horizontally are known commonly as LEDGERS.

2.44 Square Lashing (Figure 31)

This is used to lash together two poles that touch and cross at right angles.

Stage 1: Start with a clove hitch (a) round the standard, below the ledger, marrying the ends as at (b). Take the married ends up and around both standard and ledger as depicted by arrows.

Stage 2: Repeat this circuit three or four times working inwards on the standard until the gap is filled, keeping the rope as taut as possible.

Stage 3(a): Take three or four frapping turns (c) around the whole lashing between the spars, draw taut and finish with a clove hitch.

Stage 3(b): The square lashing as viewed from the back.

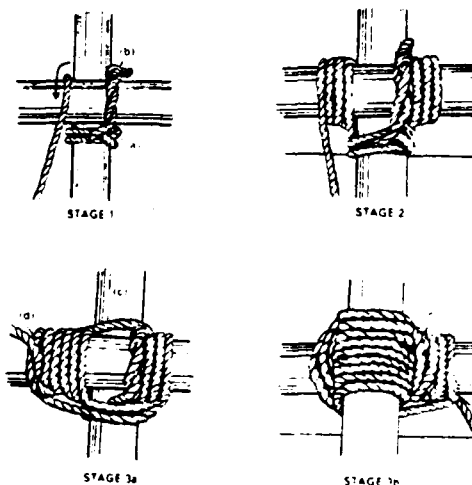


Fig 31.

2.45 Diagonal Lashing (Figure 32)

This is used to lash together two touching poles at an angle, especially when their mode of use may cause them to spring apart.

Stage 1: Start with a timber hitch (a) round both poles horizontally, then take four vertical turns (b) and draw taut.

Stage 2: Take four horizontal turns (c) and draw taut.

Stage 3: Finally, put four frapping turns (d) over the lashing, between the spars, draw well taut and finish with a clove hitch.

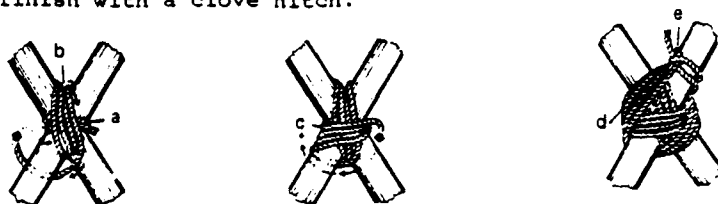


Fig 32.

2.46 Round Lashing (Figure 33)

This is used to lash together two poles which lie parallel to each other. Insert spacing pieces. Start lashing with a clove hitch round one pole and continue with 6-8 close turns round both poles, travelling upwards. Make two or three frapping turns round the lashing and secure with a clove hitch on the opposite pole to the beginning of the lashing. Do not remove the spacing pieces until the lashing is completed.

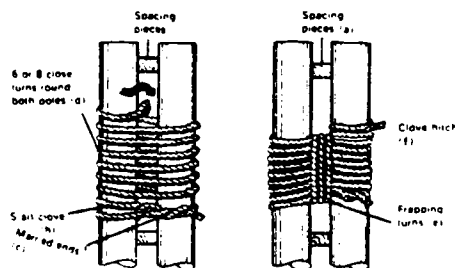


Fig 33.

2.47 Figure of Eight Lashing (Figure 34)

This is used to lash three parallel poles together, as may be necessary for instance to form a tripod or gin (gyn). Spacing pieces about 50mm wide should be inserted (a). Start with a clove hitch (b) around one of the poles, with the ends married. Working upwards all the time, from the first clove hitch, continue lashing in figure of eight fashion with 6-8 turns (c). Make two or three frapping turns (d) round the lashing, repeat at (e). Finish with a clove hitch (f) on the opposite pole to the beginning of the lashing.

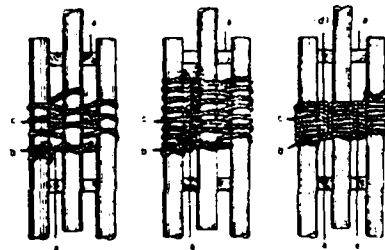


Fig 34.

SPLICING

2.48 Splicing Laid Rope

By far the strongest and most efficient method of joining two ropes or forming closed loops at rope ends is by splicing. Even the most efficient knots will reduce the strength of a length of rope considerably, whereas a carefully made splice causes little reduction of strength, and with some practice, splicing is a simple operation.

The splices most often used in rescue ropework are:

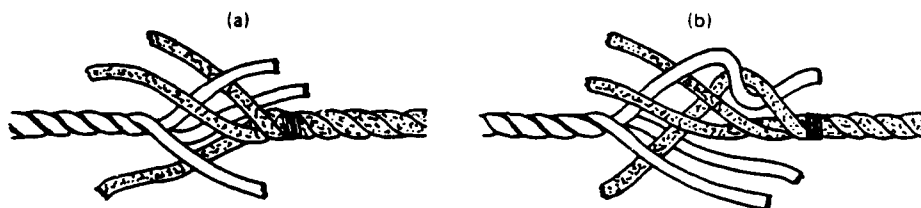
- Short Splice.
- Long Splice.
- Eye Splice.

2.49 The Short Splice

This is the strongest of all methods of joining two lengths of laid rope, but because it nearly doubles the diameter of the rope, the splice will not easily pass through a pulley or block, and it may become chafed or abraded quite quickly.

A temporary tie is placed around each rope at a distance of about ten times the rope diameter from the rope ends. Each rope end is then unlaid to this tie point and the two ends are placed together as shown in figure 35a, so that the strands of one rope go alternatively between the strands of the other.

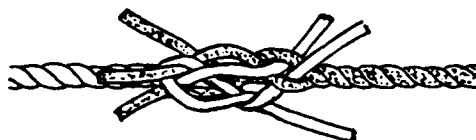
Fig 35



One of the ties is removed, and any one strand from that rope is brought over the opposing strand next to it and under the next opposing strand against the lay of the rope (Figure 35b).

This last step is repeated with the other two strands. The ropes are then turned end for end, the other tie is removed and the same tucks made over and under the strands alongside in the opposite direction. (Figure 36)

Fig 36.



All tucks should be pulled tight evenly, and the procedure continues, taking alternative tucks until three tucks have been made by each strand of each rope end.

The strand ends are cut off, leaving a short length of each outside the splice, and the entire splice is rolled between the palms of the hands to settle it down and to balance all of the tucks.



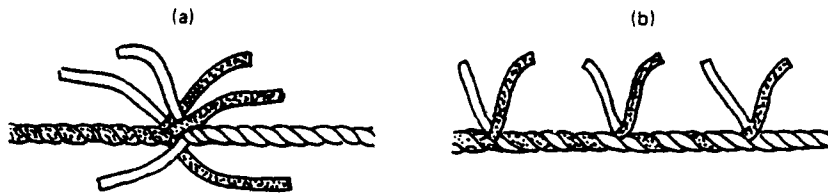
2.50 The Long Splice

A correctly formed long splice results in a very slight increase in the diameter of the rope, making it suitable for passing through blocks or pulleys. This splice is not as strong as the short splice however, and care must be taken to ensure that the rope system is not dangerously weakened.

Each strand end is whipped, and each end of rope is unlaid for approximately sixty times the diameter of the rope from the ends. The ends are then brought together as shown in Figure 37a (strands depicted shorter than actual length), with each strand alternating between two strands of the opposing rope.

Each strand is unlaid and replaced closely with the correct strand from the opposing rope end, with the original twist retained in the strand. This is then repeated with the other rope end as shown in Figure 37b.

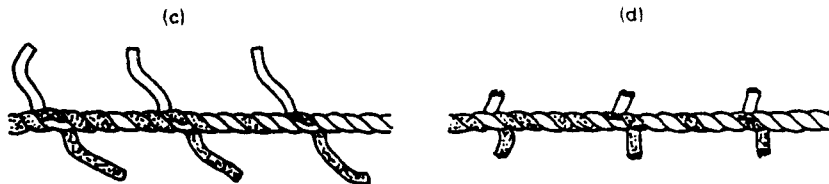
Fig 37.



Each pair of strands is tied with an Overhand Knot as shown in Figure 37c. Each strand is then tucked over and under the strand alongside, working with the lay of the rope, and pulled tight. One third of the yarns in the strand are cut out, and another tuck is taken around the same strand. One half of the remaining yarns are then cut out of the strand and it is tucked around the same strand yet again.

This procedure is repeated with each strand, and the splice is completed by cutting the protruding strands until they project about one rope diameter in length from the splice (Figure 37d).

Fig 37.



The entire splice is dressed by rolling it between the palms of both hands.

2.51

#### The Eye Splice

The eye splice is used to form a strong and permanent loop or eye at the end of a rope, or for any situation where the rope end must be spliced back into the standing part at any point. These notes describe a 'plain' or 'soft' splice for normal use. When made up for heavy duty operations, the splice should be formed around a metal or Nylon 'thimble', when it would be referred to as a 'reinforced eye splice'.

The rope end is unlaidd for a distance of about fifteen rope diameters from the end, and the rope is turned back to form the required eye size. The separated strands are then tucked into the standing part as shown in Figure 38a.

The strands are laid across the standing part approximately at right angles to the lay, with two strands on top and one under the standing part. One strand of the standing part is lifted with a splicing fid or spike, and the No. 2 strand from the running end is tucked under it. (Figure 38a)

The next standing part strand is lifted and the No. 1 strand is tucked under it, entering the lay where the No. 2 comes out. (Figure 38b)

Fig 38a.

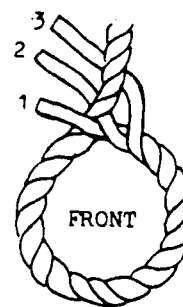
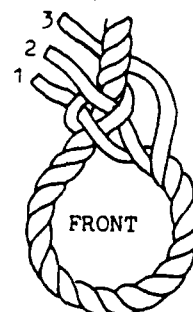


Fig 38b.



The eye is turned over, and No. 3 strand is inserted under the only strand which has no other under it. The direction of the No. 3 strand should follow that shown in Figure 38c.

All tucking strands are pulled firmly into place, completing the first tuck run. Each strand is then taken in turn over one standing part strand and under the next one as shown by the No. 2 strand in Figure 38d, until three tucks have been taken with each running end strand into the standing part.

The strand ends are cut off leaving a short projection from the splice, and the splice is rolled by hand to balance the tucks.

Fig 38c.

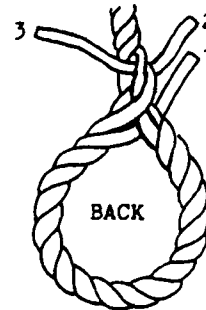
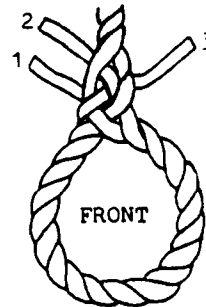


Fig 38d.



## 2.52 Special Safety Precautions

When splices are made in synthetic ropes, additional care must be taken as the splice may slip when under load. An additional tuck or two should be added for each splice, and the ends of the splices should be whipped or heat sealed to retain the strand ends.

## 2.53 Strengths of Splices

The following are the approximate residual breaking strains of new rope in which splices have been formed:

Short Splice	80-90%
Long Splice	60-70%
Eye Splice	85-95%

## CHAPTER THREE

### LADDERS

3.0 Ladders play a very important part in Rescue Operations; not only are they used for climbing but also for bridging gaps, derricks, slides and stretchers. Rescue personnel should understand their basic construction, care and handling techniques and become proficient in their use. To develop teamwork, practice with ladders is essential.

#### 3.1 Terminology

The following are standard ladder terminologies.

- |                     |   |   |
|---------------------|---|---|
| a. Strings          | - | The main structural part of a ladder.   |
| b. Rungs or Rounds  | - | Cross members used in climbing a ladder.                                      |
| c. Straight Ladder  | - | A one piece ladder.   |
| d. Extension Ladder | - | A ladder built in sections.   |
| e. Foot             | - | The bottom or ground end of a ladder.   |
| f. Head             | - | The top of a ladder.  |
| g. Halyards         | - | Pulling lines for raising extension ladders.                                  |
| h. Pawls            | - | Metal hooks fitted to extension ladders to lock the ladders in extended form. |

#### 3.2 Ladders - Construction, Care and Maintenance

Ladders come in a variety of styles, lengths and materials. Aluminium, Timber and Fibre Glass are the three more commonly in use. This chapter will deal specifically with timber 2.5 to 4m and 5 to 9m extension ladders, but the details outlined are applicable to all sizes in use.

##### Extension Ladders (Figure 39)

Extension ladders are commonly in two sections, with the upper section sliding on and between the strings of the lower section. Pawls are fitted to the lower end of the sliding section and operate on a movable shaft. Pulling lines (Halyards) are taken through a sheave fixed near the top of the lower section, brought down and fastened to hooks or cleats at the bottom of the

sliding ladder, one cleat being attached to the pawl shaft thus providing endless lines by means of which the top section can be extended and the pawls, which are mounted on the sliding section, can be engaged or released. To make it easily distinguishable in the dark, the strings of the top section should bear a white line to indicate the limit of safety when extended for use. The overlap of the ladders is normally five rungs. Similarly, the bottom of the ladder should have a band of white paint 100 to 150 mm wide. The ladder is strengthened on the underside of all strings by galvanised wire or fibre glass which is stretched tautly in the groove along the edge of the strings being secured top and bottom.

Ladders are further strengthened by cross ties of wrought iron rod from string to string at intervals. Ladders should not be painted as paint could hide incipient defects. A section, of no more than 300mm, from each end may be painted for identification purposes.

Clear varnish or treating the bare wood with linseed oil usually proves satisfactory.

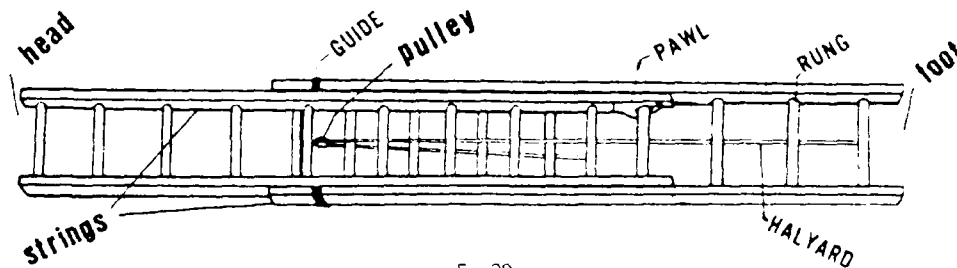


Fig 39.

### 3.3 Testing Extension Ladders

- a. Extension ladders should be tested 3 monthly or more often if necessary. The first test is a visual examination followed by a practical test of the strings and rungs.

- b. Examine the condition of the strings, rungs, pulley and pawls and lubricate working parts. Look for obvious defects especially any displacement of anchoring or reinforcing wires or fibres, cracks or shakes in the strings or rungs, loose rungs or missing wedges, riveting or cross ties and position of washers, bent or twist pawls or pawl shaft, bent cleats, loose guides, frayed ropes and defective fastening of ropes to pawl shafts. Pay particular attention to the condition of the strings at the bottom of the lower half of the ladder.
- c. If the examination is satisfactory, lay the ladder flat on the ground with the strengthening wire on the strings toward the ground. Extend the ladder to a five run overlap on each half, lift it on to two trestles (or boxes) positioned about 60cm from each end; measure the distance of a point in the middle of the span from the ladder to ground.
- d. A man of around 70-75 kg should sit gently on the centre of the ladder and after it has reached the limit of sag he should spring off smartly, when the ladder should resume its previous position. If there is a discrepancy between the first and second measurements, further inspection should be made, paying particular attention to the anchoring or stretching of the reinforcing. If it appears that serious stretching has taken place in the reinforcing or other defects become apparent during this test, the ladder should be returned to store for repair or disposal.
- e. To test the extending rope, the ladder is erected in its closed state against a wall. Two men grip a rung of both upper and lower sections together to prevent any sliding movement whilst two men endeavour to extend the ladder by hauling on the rope. If the rope proves to be sound, the ladder is extended to its full height and two men again apply their weight to the rope.
- f. After this test, the ladder should be halved (see paragraph Halving Ladders) and each half raised so that the weakest part of the rungs and sockets may be tested. Each rung should be "jumped" by a man who has ascended the ladder. The correct method is to transfer the man's weight sharply downwards as far as the strings permit. The height of the "jump" should not be increased nor used to deliver a violent blow to the rungs. The ladder should be erected as near to the vertical as safety permits with the head being secured and 2 men stationed at the foot. The ladders should be reversed and the remaining rungs jumped.

3.4 Angle of Ladders When Raised

When a ladder is raised, the angle which it makes with the ground should not be too great or too acute. As a general rule the bottom of the ladder should be placed at a distance from the base of the wall equal to one quarter of the height to be reached. Eg. to enter a window 8 metres above the ground the ladder should be footed about 2 metres from the wall.

3.5 Securing the Top of the Ladder (Figure 40)

When it is necessary to secure the top of a ladder, this may be done with a lashing or length of sashcord. The usual method is to tie it to a piece of timber which is long enough to spread across and inside the width of the window opening.

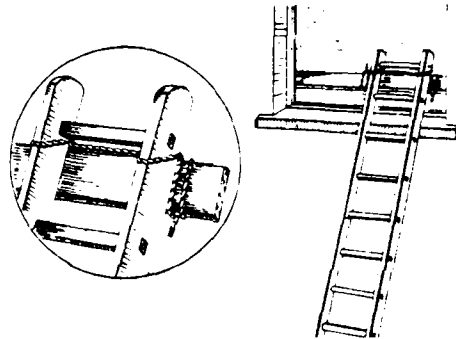


Fig 40.

3.6 Anchoring the Foot of the Ladder (Figure 41)

This may be done by means of fastening to an improvised picket or pickets or tying back to any secure object behind the ladder eg. railings, fence posts etc.

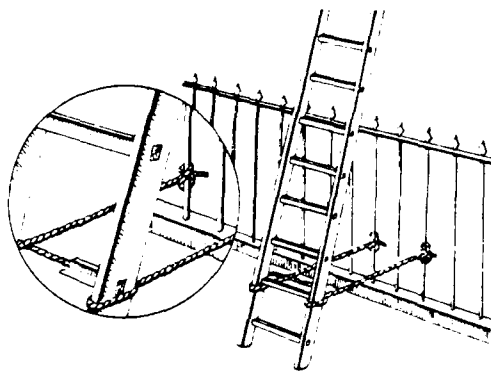


Fig 41.

3.7 Ladder Climbing (Figure 42)

The ladder should be climbed steadily, keeping the body erect, the head upright, arms straight but not tense, without any tendency to hug the ladder and hands grasping the rungs at a level between the wrist and shoulders. It must be remembered that the legs and not the hands carry the weight of the body when climbing. It is generally agreed that it is safer to use the instep rather than the ball of the foot on the rungs. However, it should be left to the individual to make his own decision.

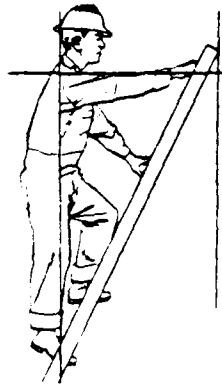


Fig 42

3.8 Erecting and Extending the Ladder (Three Man)

Normally three men are required to form a ladder team. No 1 is responsible for the bottom of the ladder, both in carrying and positioning where necessary. Nos 2 and 3 support the uppermost string of the ladder on their shoulders. On arrival at the site required for erection, No 1 places the bottom of the ladder with the reinforcing wires uppermost as near as possible to its required position and anchors it by "footing". Nos 2 and 3 working on their respective sides raise the ladder from the underneath side, to the vertical position assisted by No 1 as soon as it has reached a suitable slope to enable him to grasp the sides and exert his pull. If the reinforcing wires or fibres are not now facing toward the wall the ladder should be turned in the required direction. Provided it has been correctly placed before raising there should be little necessity to handle or carry it far from the position.

Nos 2 and 3 face the ladder, each "footing" it, then pulling on the ropes, extend the ladder to the required height ensuring that the pawl is properly engaged on the rung. The ladder is then laid back by No 1 who walks backward until the top of the ladder comes to rest where required ie. against sill, wall etc.



3.9 Erecting and Extending the Ladder (Two Man)  
(Method 1)

When no third man is available to foot the ladder, the bottom of a ladder should be placed against a wall, kerb or some other fixed object. The ladder is under-run in the usual manner by the two men, extended to the required height and the foot of the ladder drawn outwards to the correct distance from the wall.

3.10 Erecting and Extending the Ladder (Two Man)  
(Method 2)

Position the ladder parallel to the building with the foot directly below the point where the top is to rest. (Figure 43). Turn the ladder over until it rests on one string with the reinforcing wire inwards. No 1 foots the ladder by placing his foot on the bottom string while reaching out and grasping the top string with his hands well spaced. No 1's other foot is held well back to act as a counter weight. No 1 aids in raising the ladder by pulling as much as possible with his extended hand while footing the ladder string. No 2 faces the top of the ladder and with his inside hand, palm back, grasps a rung about two thirds of the distance back and raises the ladder over his head. He swings under it and pushes the ladder upward while walking towards the foot. Once the ladder is upright, the two men move into position on opposite sides facing each other through the ladder. The inside man No 2 (nearer the building) steadies the ladder while the outside man No 1 extends the top section and secures it into place by ensuring the pawls are seated on a rung correctly. No 1 places one foot on the lowest rung of the ladder and eases the top against the building.

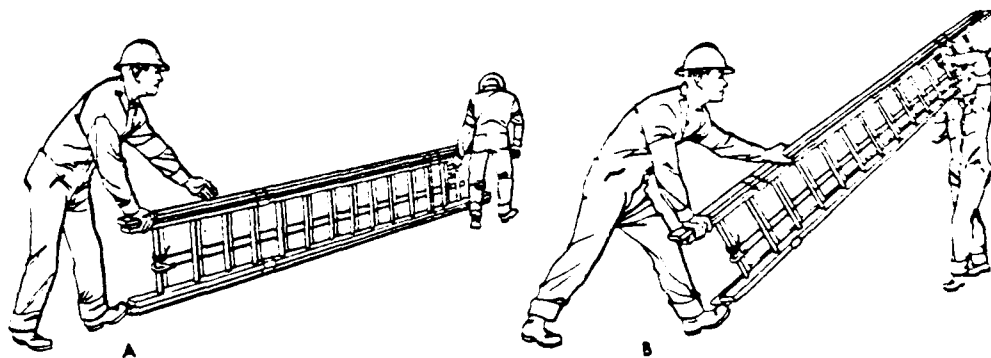


Fig 43.

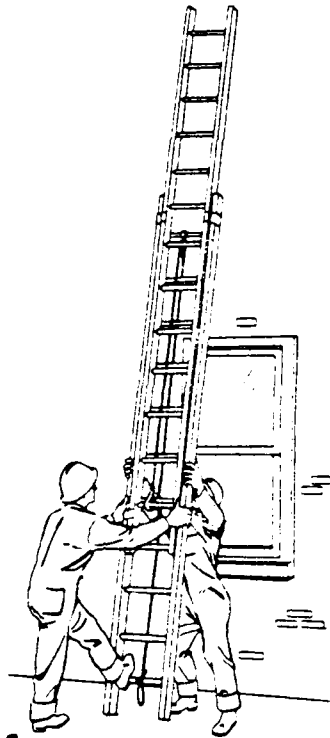


Fig 43.

### 3.11

#### Halving Ladders

In some cases it may be imperative to have two short ladders when only one long extension is available. This can be achieved by halving the extension ladder, ie by removing the sliding extension from the main ladder. The ladder should first be placed on the ground, the sliding section uppermost. The ropes are uncoupled from the hooks or cleats, the pawls freed and the upper extension withdrawn. To reassemble: The upper extension is placed between the strings of the main ladder and pushed forward into its correct position. The ropes are reconnected to the cleats, pawls are placed in position on the lowest rung of the main ladder.

CHAPTER 4  
CASUALTY HANDLING

- 4.0 Rescue will be conducted under almost every conceivable adverse condition. The method used for casualty removal will depend on the location of the casualty and the type of injury he has sustained. In some rescue operations casualties will have to be lowered from the upper floors of buildings; in others, hoisted from below through holes in floors; or be removed by a combination of those techniques. In most cases, casualties will be handled by rescue personnel and care must be taken to ensure that further aggravation of the injury does not occur.

After removal, many will have to be carried over piles of debris and uneven ground before being turned over to the Ambulance Service or First Aid Station. Some will be seriously injured; some unconscious, therefore speed of removal is important, but it should be consistent with safety and proper handling to prevent further injury. The method used will depend on the immediate situation, casualties' condition, types of injury and available equipment. Rescue leaders should conduct frequent exercises in the removal of casualties, using live persons as casualties to give team members understanding and confidence in the various methods, enabling them to make decisions promptly in times of emergency. As important as learning the methods, rescuers should experience the physical effort required in transporting casualties, either by stretchers or by some improvised method. The transportation of casualties over long distances is a very tiring task and requires fit manpower.

CLASSIFICATION OF CASUALTIES

- 4.1 All casualties who require treatment can be broadly classified under three main headings:

- (a) Walking injured.
- (b) Slightly Injured Casualties.
- (c) Seriously Injured Casualties.

WALKING INJURED - The term is self explanatory but the following are examples of some types of casualties who should not be allowed to walk:

- (a) If there is a marked degree of shock.
- (b) If there is the slightest doubt of internal injuries.

- (c) Casualties who have bled or are bleeding from an artery, even a small wound.
- (d) Casualties who have head wounds even though they may appear to be slight.
- (e) All cases of poisoning by a nerve or lung irritant gas.

SLIGHTLY INJURED CASUALTIES - are those whose injuries require that they must be evacuated for further treatment, but the nature of the injury does not necessitate the use of a stretcher and evacuation can be effected by a sitting care car. A few examples of slightly injured casualties are:

- (a) Cases of serious shock
- (b) Casualties with an injury to a lower limb unless it is only a slight flesh wound.
- (c) Cases who appear to be suffering from gas poisoning or radiation sickness.

SERIOUSLY INJURED CASUALTIES - are those who will probably require hospital treatment. A few examples of seriously injured casualties are:

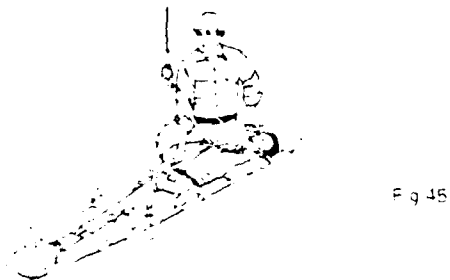
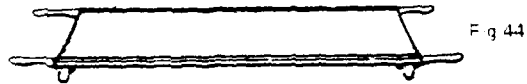
- (a) All cases of internal haemorrhage; open wounds of the chest; shattered limbs; grossly lacerated and crushed limbs; wounds of the stomach; open complicated fractures; fractures of the skull, spine, pelvis and thigh; injuries involving the eye; injuries involving the lower jaw and control of the tongue.
- (b) Cases of external haemorrhage and multiple or extensive burns.
- (c) Cases in which further shock is likely to supervene, as in persons trapped for long periods under debris or exposed to cold and wet; in fact all but those with trivial injuries or who are merely shaken, frightened or faint. It must not be forgotten that very small external wounds may well be associated with damage beneath the surface.
- (d) All diabetic patients who may be injured or who are suddenly taken ill.

#### STRETCHERS

4.2 Two types of stretchers are commonly in use; these being:

- (a) The folding or pole stretcher FIG 44.

- (b) The basket stretcher FIG 45 (often referred to as a STOKES LITTER)



#### 4.3 PREPARING THE FOLDING OR POLE STRETCHER

The folding stretcher must be set up before a patient can be transferred to it.

- (a) Unfasten the straps that hold the stretcher closed (if fitted)
- (b) Spread open the stretcher and lock the spreaders in place by pushing on each bar WITH YOUR FOOT, until it locks into place. DO NOT USE your hands as fingers can be pinched by the hinges.
- (c) Where it is possible that the centre hinge of the spreader bar may be snagged, unlocking the hinge and collapsing the stretcher, a securing rope should be used. A short length of sashcord can be tied from one stretcher handle to the centre hinge and then to the other stretcher handle in Vee pattern. The Clove Hitch is ideal for all three knots of this rig.

#### 4.4 BLANKETING A STRETCHER

Before a casualty is placed on a stretcher, it should be covered with a blanket so that no contact is made with the canvas bed portion. This adds to comfort, keeps warm and to a large degree helps immobilise any

fractures that may have been sustained. Depending on the weather and on the supply of available blankets, one or two blankets can be used. In very warm weather a cotton bed sheet or sheets may be used.

4.5 TWO BLANKET METHOD (Figure 46)

- (a) Lay one open blanket length ways across the stretcher, level with the head end with about one-quarter of the blanket on one side of the stretcher and one half of the other. FIG 46a
- (b) The second blanket is placed with its centre in the middle of the stretcher and its head about 40cm from the top. The sides are then folded into the centre and out of the foot. FIG 46b
- (c) The casualty is then placed on the stretcher with the head level with the top of the canvas.
- (d) Blanketing is commenced by taking the centre of the second blanket in between the ankles of the casualty (to prevent chafing) and crossing the end points of this blanket over the legs and tucking them in. These points should be taken as far up towards the knees as possible.
- (e) The short side of the first blanket is taken over the body of the casualty and if possible, tucked in.
- (f) The final operation is to tuck the long side of the first blanket on the opposite side of the stretcher. FIG 46c

In both steps (e) and (f), the tips of the blanket should be folded in so as not to obscure the casualty's face. If operating in a wet or contaminated area, it is advisable to concertina the ends of the first blanket down the sides of the stretcher before the second blanket is placed in position. This keeps it clear of the ground and can be easily pulled out when required.

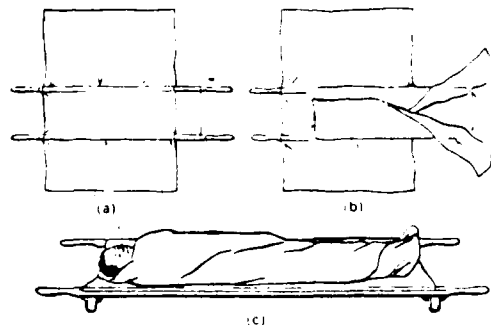


Fig 46.

4.6 ONE BLANKET METHOD (Figure 47)

- (a) Lay one open blanket diagonally down the stretcher with the corner of the blanket in the centre of the top of the stretcher, and about 15cm overlapping.
- (b) Place the casualty on the blanket with the head level with the top.
- (c) Fold over and tuck in the lower half of the blanket.
- (d) Do likewise with the top half.

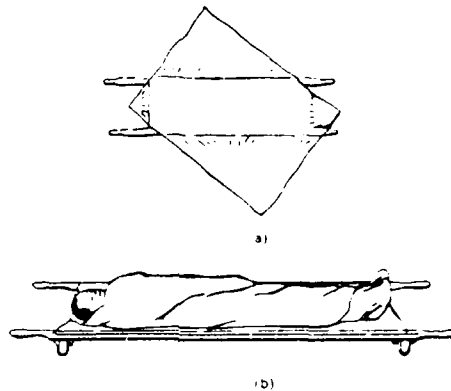


Fig 47

4.7 IMPROVISED "BLANKETING"

An alternative method of providing wraparound protection when no blankets are available is by the use of a tarpaulin:

- (a) Lay the tarpaulin on the stretcher with about one metre overlapping the head end of the stretcher.
- (b) Fold the head end in 20cm folds to form a headrest.
- (c) Fold the bottom of the covering over the patient's feet.
- (d) Fold one side of the cover over the patient and fold and tuck in the excess.
- (e) Repeat the above procedure with the other side.

#### 4.8 STRETCHER LASHING

In many cases casualties will have to be firmly secured to the stretcher to enable it to be handled in difficult places. No hard fast rule can be laid down as to when a casualty should or should not be lashed on, however, the nature of the rescue should in itself provide the answer. If in doubt, lash the casualty in.

The ideal size and length of rope for stretcher lashing is 12 metres of 12mm rope. Although any cordage, electrical flex, clothes line etc will suffice in an emergency.

Commence the stretcher lashings by taking a clove hitch around one of the top stretcher handles. From this point take three half hitches around both the casualty and the stretcher, first in the region of the chest, the second in the vicinity of the wrists and the third hitch just above the knees. FIG 48

A round turn is then taken around the feet and three half hitches applied to those already formed on the opposite side of the casualty's body. The lashing is finished as it was started, with a clove hitch on the remaining top stretcher handle.

It is well to remember that the position of the three securing half hitches can be varied according to the location of the injuries which the casualty has sustained and in the case of a female casualty, the top securing hitch should be placed just below the breast line.

Bricks or timber placed under the stretcher "Ds" before lashing commences will enable the rope to be passed under the stretcher more easily.

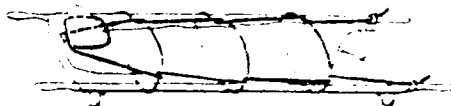


Fig 48.

#### 4.9 STRETCHER LASHING - COMA POSITION

Should it be necessary to transport a patient in the Coma position on a stretcher, the method of blanketing and lashing will differ slightly to the previous method.



4.10 BLANKETING

In addition to warmth, comfort and immobilisation, the blanket is used for padding to keep the patient in the required coma position.

The following is the recommended method:

- (a) Roll a blanket end to end and position it on the stretcher as in figure 49a

The rolled portion is used to pad the patient's back.

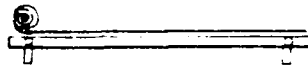


Fig 49(a).

- (b) A second blanket is placed on the stretcher in a similar manner with the rolled portion on the opposite side and the blanket folded over the patient and tucked under the first roll as in figure 49b.



Fig 49(b).

4.11 LASHING (Figure 50)

The lashing of the stretcher differs from the normal method in that the rope does not pass around the feet. It is passed through the "Ds" of the foot of the stretcher.



Fig 50.

4.12 PREPARING THE BASKET STRETCHER

Two types of basket stretcher are available. The older type has a strong tubular frame covered with "chicken" wire, whereas the newer has a formed plastic, fibreglass or aluminium basket attached to a tubular aluminium frame. The plastic designs have an advantage in that they are less likely to be snagged or penetrated, than the wire model.

Other than the very old wire designs, both models can accommodate a "scoop" stretcher thus making the transfer of a spinal casualty easier.

Normally the stretchers are supplied with securing straps, four point suspension bridles and adjustable foot rests that give added security when the stretcher must be moved in a vertical position.

4.13 BLANKETING A BASKET STRETCHER

Basket stretchers should be blanketed, particularly in cold weather to ensure the maintenance of body heat particularly during lengthy rescue or transfer operations. e.g.

- (a) Lay an unfolded blanket over the stretcher, with the upper edge of the blanket just beyond the head end of the basket. Use two blankets if necessary.
- (b) Place the casualty in the basket making sure he is anatomically straight and that his hands are along the sides.
- (c) If spinal injuries are not involved a cushion for his head. A pillow, a folded blanket or a coat can be used.
- (d) Fold up the end of the blanket over the feet.
- (e) Fold over first one side, then the other and tuck the blanket in.

An alternative is to transfer the casualty inside a sleeping bag in the stretcher where attention to injuries do not preclude this method, or to lay folded blankets under the casualty for insulation.

NOTE: A Neil Robertson stretcher, used to totally immobilise a casualty when raising or lowering in rescue situations, will fit inside a basket stretcher for ease of ground level transportation.

4.14. SECURING A BASKET STRETCHER WITH SECURING STRAPS  
(Figure 51)

Newer models of both the wire basket and fibreglass basket stretchers usually have securing straps, and the preparation of an adult casualty for horizontal transfer involves little more than tightening the straps, although when the patient is small there will be gaps between the patient and the sides of the stretcher. It is not improbable that a casualty could slide out from under the straps if the stretcher was tilted.

Gaps between the casualty and the stretcher sides should be filled with blankets, clothing or pillows etc. before the straps are snapped in place. Remember that the purpose of strapping or lashing is to combine the patient and the stretcher in a solid manageable unit capable of being carried over hazardous terrain.

NOTE: If the straps are fitted with automobile seat belt type quick release buckles, these are to be turned upside down after fastening so as to reduce the risk of accidental release of the buckles or a rope lashing system used for greater security.

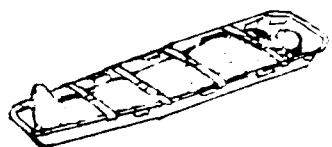


Fig 51

4.15 SECURING A BASKET STRETCHER BY LASHING Figure 52

If straps are not supplied with the basket stretcher the casualty can be lashed firmly with a 12m x 12mm lashing or similar rope.

- (a) Tie a clove hitch in the inside of the second frame (A) between the top rail and the stringer. If greater knot security is required, finish the clove hitch with a third half hitch around the frame.
- (b) Feed the lashing under the arch of the casualty's feet and up to No. 1 frame (B) on the opposite side.
- (c) Tie a clove hitch at (B) and tension up.
- (d) Pass diagonally across to and around the frame at (A).

- (e) Pass the lashing diagonally to (C).
- (f) Continue this method as per the diagram for frames D, E, F, G & H.
- (g) Finish at frame point H with a clove hitch and ensure surplus rope is safely packed away and tied off.

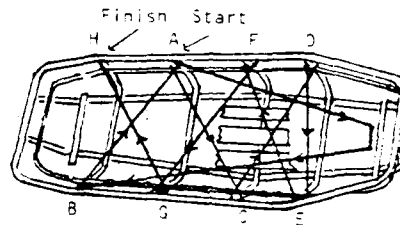


Fig 52.

NOTE: If the basket stretcher has no leg divider, the casualty's feet should be secured together with a Full Turn. If the casualty is to be shifted in a vertical position the head of the patient must be secured. Pack soft material on either side of the casualty's head and tie a length of bandage to one lower rail, lay it over the casualty's head (not his eyes) and tie the other end to the opposite lower rail.

#### 4.16

##### IMPROVISED STRETCHERS

In any disaster of a major nature, it is realistic to say that there will be insufficient stretchers for the number of casualties involved.

There are many methods of improvisation and ones imagination should be used when confronted with the problem, however, a number of the more obvious methods are described.

#### 4.17

##### DOORS (Figure 53)

These are probably the most readily available improvised stretchers - providing the building has not been completely burnt out, they should be in reasonably good supply.

Blanketing is exactly the same as for the folding stretcher, the lashing however requires a slight modification. Two members can be used:

- (a) Bore two holes in the head of the door adjacent to the casualty's head and pass the lashing through these to commence; finish it by tying thumb knots on the opposite side of the door.
- (b) Take a round turn around the head of the door securing the running end of the lashing to the standing part with a clove hitch, leaving around 60mm of running end free.

In both cases the lashing is applied in the normal way, but in case (b) the lashing is made off with a clove hitch on the turn around the top of the door, then taken over the top and clove hitched to the same turn on the opposite side of the door. The same procedure is carried out with the tail left over when tying the original clove hitch.

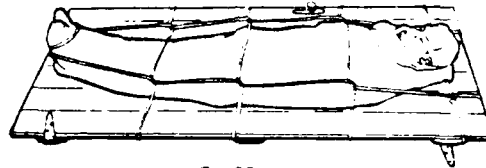


Fig 53.

4.18 BLANKETS (Figure 54)

Blankets make an excellent improvised stretcher and in residential areas, should be in fair supply. These are very simple to make and in addition to the blankets, require two poles about two metres long. Stout broom handles, water pipe or 50mm x 25mm timber would do.

Place the blanket flat on the ground and lay the poles on the blanket about 600mm apart.

Fold each side of the blanket across each pole and the stretcher is ready.

To make it more secure, nails can be used to pin the two top folds together.

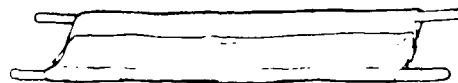


Fig 54.

4.19 BAGS (Figure 55)

Two bags and two poles make a first class stretcher. Cut the stitching in the bottoms of two bags, just enough to permit the poles to be passed through. Slide the end of the second bag a short distance over the foot of the first bag.



Fig 55.

4.20 OVERCOATS (Figure 56)

Two overcoats with the sleeves turned inside out and poles slid through them make a good stretcher.

Do up all the buttons on the front of each coat and, if necessary, use nails to close the tail flaps.

The coats are placed head to tail with the fronts of the coats uppermost.

Heavy shirts or overalls can also be used in the same manner.



Fig 56.

4.21 LADDERS

Where for any reason a very narrow stretcher is required, such as for passing through small window openings, tunnels, etc, half a 4-5m extension or similar straight ladder can be used to advantage.

A decking of boards should be placed on the ladder (if available) and it is then blanketed in the normal way. In FIG 57 a variation to the standard stretcher lashing is shown. It is commenced with a clove hitch on the string above the rung nearest the casualty's feet. Two loose round turns are then taken around the ladder and the lashing half hitched to the centre. From here three half hitches are taken around the body in the usual positions. The lashing is tied off with a clove hitch to a rung above the casualty's head.



Fig 57

4.22 BEDFRAMES (Figure 58)

These make a good stretcher, but in most cases tend to be too wide for easy handling.

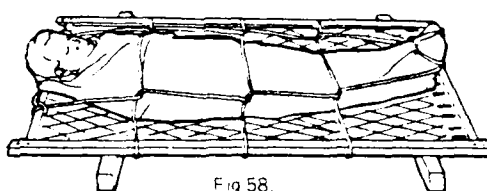


Fig 58

4.23 CORRUGATED IRON

Sheets of corrugated iron make good stretchers and in most built up areas are available in almost unlimited supply. The sides of the sheet (about 2 corrugations wide) should be folded under to strengthen.

4.24. CHAIRS (Figure 59)

Strong kitchen type chairs, although not strictly a stretcher should never be overlooked in an emergency.



Fig 59.

4.25 LOADING A STRETCHER

Loading a stretcher is an important part of casualty handling in so much as bad handling can seriously aggravate, or increase, the injuries a casualty already has. Care and gentleness must be used at all times.

4.26 THE FOUR MAN METHOD

If four rescuers are available and there is a reasonable amount of space, this is probably the best method.

- (a) Make the stretcher ready and place near the casualty's head or feet.
- (b) The leader details three others to kneel down on one knee, on one side of the casualty (casualty lying flat on back). They all have the knee up closest to the casualty's head.
- (c) Leader kneels near the casualty's buttocks on the opposite side to the three others and eases the casualty on to his side.
- (d) The other three place their hands and arms underneath the casualty and the leader lowers the casualty.



- (e) The leader gives the order, "Prepare to lift" and if no one dissents, follows it with "lift" - whereupon the other three, assisted by the leader, lift the casualty up and support him on their knees. FIG 60.
- (f) The leader then gets the stretcher and places it on the ground with the top level with the casualty's head.
- (g) Final orders are "Prepare to lower" - "Lower".
- (h) The other three, assisted by the leader, lower the casualty on to the stretcher.



Fig 60.

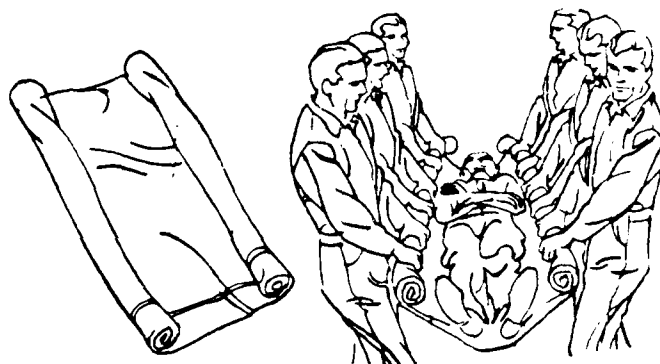


Fig 61.

4.27 BLANKET LIFT (FOUR OR SIX MAN) (Figure 61)

This is probably one of the best methods for loading or moving a casualty in a confined space.

- (a) Make a stretcher ready using one blanket only.
- (b) Fold a blanket lengthwise and lay the folded edge along the side of the casualty (casualty flat on back).
- (c) Roll the folded edge back to about half the width of the blanket.
- (d) The leader then directs two (or three) rescuers to kneel down (including himself) on each side of the casualty. The rescuers on the opposite side ease the casualty over on his side and the rolled section of the blanket is pushed well underneath the casualty.
- (e) With the rolled up section of the blanket now under the centre of the casualty, he is eased over in the opposite direction and the blanket is unrolled. The casualty should now be lying flat on his back, with two thicknesses of blanket beneath him.
- (f) The sides of the blanket are then rolled up to provide handgrip for the bearers. FIG 61
- (g) On the order from the leader, the casualty is lifted waist high, and carried to the stretcher.

- (h) On the order of the leader, the casualty is lowered with his head level with the top of the stretcher.
- (i) The blanketing is then completed with one blanket, leaving the lifting blanket in position.

This "blanket carry" can also be used as an improvised stretcher for carries over moderate distances.

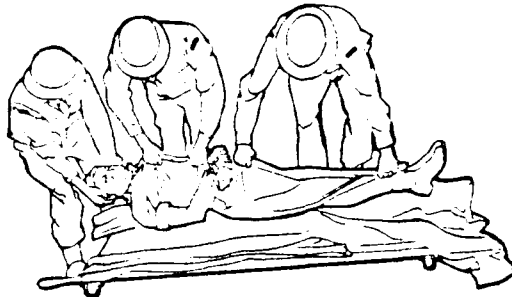


Fig 62

4.28 CLOTHING LIFT (THREE MAN) (Figure 62)

This is a simple method which can be used to advantage when the casualty's injuries are not too severe and time is at a premium.

The casualty should be fairly light.

- (a) Blanket a stretcher and place it close to the side of the casualty.
- (b) Tie the casualty's hands together - a handkerchief is quite adequate.
- (c) Roll the casualty's clothes together along the centre of his body.
- (d) Three rescuers take up position on the opposite side of the casualty to the stretcher and position their hands as illustrated in FIG 62.
- (e) The normal commands are given eg, Prepare to lift etc, and the casualty is gently placed on the stretcher.



Fig 63.

#### 4.29 WEBBING BANDS (FIVE MAN)

In some cases it may be found necessary to transport a casualty some distance to a place where a stretcher can be loaded. Webbing bands can greatly assist this operation. There are many configurations which can be used, one of which is illustrated at FIG 64.

The bands are placed in position by pushing the long steel handle under the small of the back and see-sawing them into the required position, ie, under the buttocks and shoulders. FIG 63.

After the bands have been correctly positioned, the handles of each band are centred in the middle of the casualty and the five rescuers' bearers take up position.



Fig 64.

The use of webbing bands should never be overlooked when casualties are trapped in tight and difficult positions. They literally provide lugs on the casualty which can be grasped either by rescuers' hands or lines attached to them.

#### RESCUE TECHNIQUES USING NO EQUIPMENT

4.30 This subject is discussed under two headings:

- (a) One man and no equipment.
- (b) Two men and no equipment.

It must be clearly understood that the following techniques are for use in an emergency and that generally speaking seriously injured casualties should, if possible, be placed on a stretcher.

However, conditions such as fire or imminent danger of building collapse, may dictate that removal from the scene is the first priority. In some cases this may even take precedence over stoppage of bleeding.

#### ONE MAN AND NO EQUIPMENT HANDLING TECHNIQUES

4.31 ONE MAN HUMAN CRUTCH

For this method to work, the casualty must be conscious to a degree and capable of giving the rescuer some assistance. FIG 65 clearly indicates how the one man human crutch is applied. However, it is well to note the position of the rescuer's hands, one holding the casualty's wrist and the other taking a firm grip of his clothes at the waist on the far side of the body. The injured side of the casualty should be closest to the rescuer.

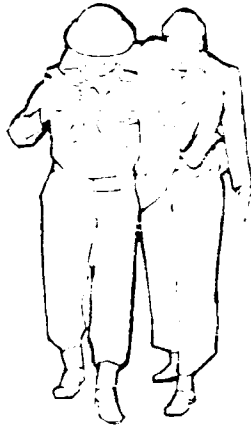


Fig 65

4.32

PICK-A-BACK

This is a well known method, but there is a pitfall of which the rescuer must be aware.

When the casualty has been loaded (he must be conscious to a degree), care should be taken to ensure that he is supported well up on the rescuer's hips and his body literally draped across the rescuer's back FIG 66a. Notice in FIG 66b, where the casualty is incorrectly positioned, the rescuer is himself off balance and likely to fall.

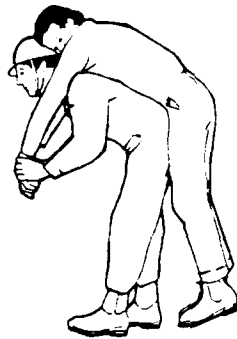
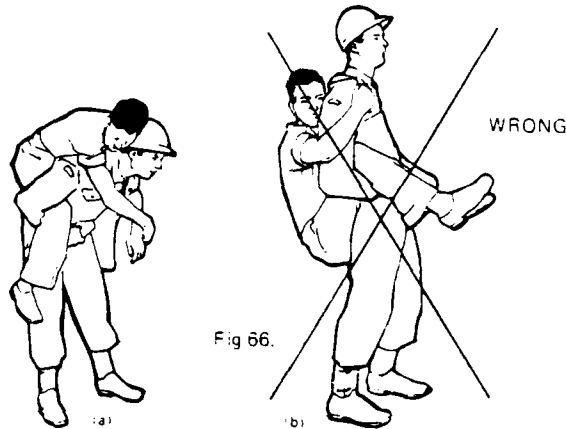


Fig 67.

4.33 ARM LIFT (Figure 67)

This is a better alternative to the pick-a-back method in that the casualty is much better supported.

To prevent injury it is important that the casualty's arms are turned inwards before lifting.

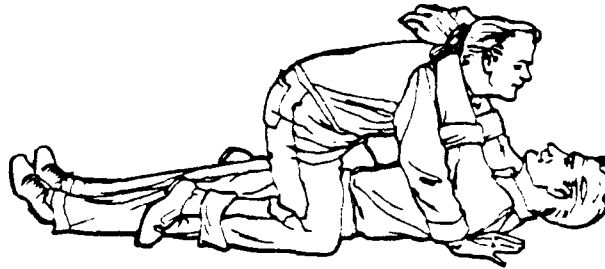


Fig 68.

4.34 FIREMANS CRAWL (Figure 69)

This is an invaluable method where a casualty has to be removed from a burning building.

As you can see in FIG 69 both rescuer and casualty have their heads low down where the clearest and coolest air are to be found if the building is on fire. It can also be appreciated that the entire weight of the casualty does not have to be supported by the rescuer.

The hands should be crossed over and tied with a handkerchief or something similar. A reef knot is adequate. The firemans crawl method can be varied according to personal preference. An alternative method is for the rescuer to place an arm and shoulder as well as the head through the casualty's arms.

4.35 REMOVAL DOWN STAIRS METHOD (Figure 69)

As the name implies, this technique has been designed to get a heavy casualty downstairs, when the rescuer cannot use the pick-a-back or other method. However, its use need not be restricted to staircases.

With the casualty lying flat on his back the first step is to tie the wrists together using a handkerchief or similar cloth. Next, the rescuer comes to his head and lifts him into the sitting position. He then reaches through under the casualty's arms and grasps his wrists. He is then in a position to drag the casualty backwards and if a staircase has to be negotiated a

large measure of support can be given to the casualty's trunk by the rescuer using his knee to ease him over each successive step. It is well to remember that the strongest part of any staircase is close to the wall.

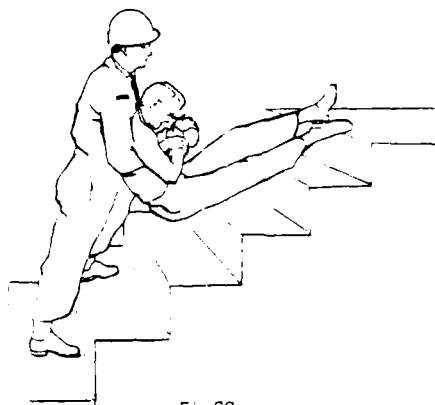


Fig 69.

4.36 HELPING A CASUALTY DOWN A LADDER (Figure 73)

Great care should be taken when helping a person down a ladder, even if that person is conscious and uninjured. Rescuers should keep in mind that most people are unaccustomed to height and may freeze up or lose their hold.

The rescuer should take up position, one rung below the casualty, with his arms encircling the casualty's body and grasping the rungs.

The rescuer should keep in step with the casualty, letting him set the pace and keeping his knees close together, to ensure support in case the other loses hold or becomes unconscious.

He should also talk to the victim to help keep up his morale and overcome his fear.

If the casualty becomes unconscious, he should be permitted to slip down until his crotch rests on the rescuer's knee. By repeating this procedure for each step down the ladder, the rescuer can lower the victim to the ground.



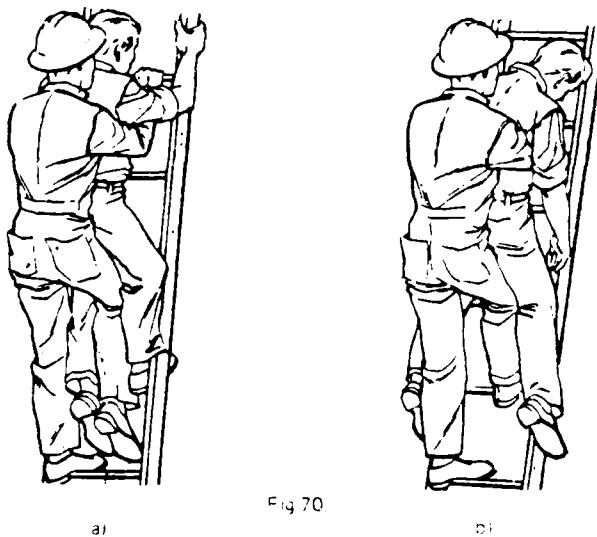


Fig 70

#### TWO MEN AND NO EQUIPMENT TECHNIQUES

##### 4.37 TWO MAN HUMAN CRUTCH (Figure 71)

As can be seen from the illustration at FIG 71, the method is similar to the one man human crutch, except that the casualty is supported on both sides.

The arms of the rescuers cross over on the casualty's back and grasp the clothing on the opposite sides of his body.



Fig 71.



Fig 72.

4.38 TWO HANDED SEAT (Figure 72)

This is a very good way of dealing with a casualty who has to be carried.

As in FIG 72a rescuers kneel on either side of the casualty, get him into a sitting position, place their right and left arms under his knees and link up with the hand to wrist grip. Their free arms are then crossed over the casualty's back, where they get a firm grip on his clothing. FIG 72 b, c.

The leader should give the normal orders for lifting and lowering.

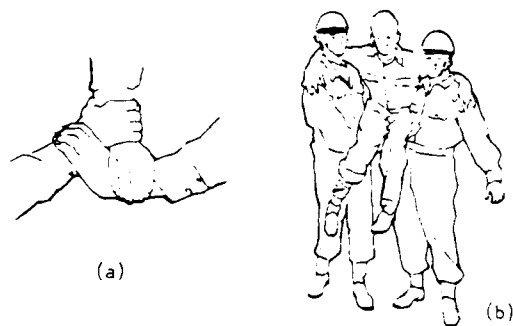


Fig 73.

4.39 THREE HANDED SEAT (Figure 73)

This method gives the casualty good support and is reasonably comfortable for the rescuers. It has the added advantage that the two man team has a spare hand for steadying.

One rescuer grasps his left wrist with his right hand and the second man places his hand and wrist as shown in FIG 73a. This forms the seat. If the casualty is capable of standing for a short period he can be loaded by placing the seat under his buttocks, but if not, the rescuers' hands must be placed under the casualty's knees first and then joined up. In either case the result should be as in FIG 73b.

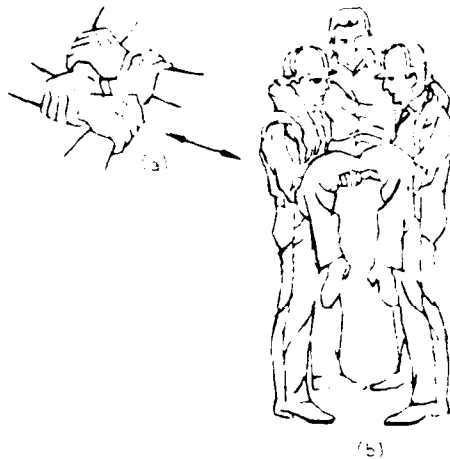


Fig 74

4.40 FOUR HANDED SEAT (Figure 74)

This is a well known method where each rescuer grasps his left wrist and the hands are joined up as in FIG 74a. This provides a comfortable ride for the casualty and places a minimum strain on the rescuers. However, as can be seen in FIG 74b the casualty must be sufficiently conscious to hold on.

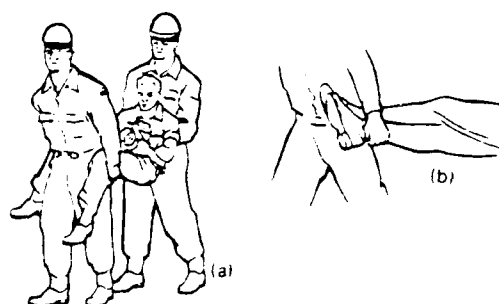


Fig 75.

4.41 THE FORE AND AFT METHOD (Figure 75)

This is perhaps the most suitable way in which two rescuers can handle an unconscious casualty.

The casualty is prepared in the same way as for the removal down stairs method ie, his wrists are tied together. The first rescuer stoops at the rear of the casualty, gripping the casualty's wrists as the second rescuer stoops between the casualty's legs grasping them underneath the knees. The standard lift orders are given and the casualty is lifted to the carrying position FIG 75a. Should the casualty have a leg injury, the effects of this can be minimised by the front rescuer crossing the casualty's legs over, then carrying them at his side as in FIG 75b.

The advantage of this method is that the rescuer supporting the casualty's feet has a free hand with which to open doors, clear debris, etc.

It is again stressed that the foregoing one and two man rescue techniques are generally confined to emergencies where removal from the scene is the first priority.

MOVING A STRETCHER OVER DEBRIS

- 4.42 A stretcher should, wherever possible, be carried in the horizontal position or slightly "head high". When moving over heavy debris this may prove to be difficult, but risks to both casualty and bearers can be reduced to a minimum by adopting the following procedures.

4.43 Using six bearers

Moving a heavy casualty over difficult debris conditions for any more than 10 or 15 metres, will almost certainly require 6 bearers. The Leader should direct three bearers (including himself) on each side of the stretcher. (N.B. the Leader normally takes the position adjacent to the casualty's left shoulder at the commencement of the operation). On the order "Prepare to lift", the bearers stoop and grasp the strings of the stretcher. When all is in readiness, the Leader gives the order "lift" and the stretcher is raised to waist height. The next order will be "prepare to pass". Any member of the team who for any reason at all is not ready should inform the Leader. Good footings on debris are hard to find and care should be taken in this regard. On the command "pass", the stretcher is passed in the direction it is required to move until such time as it is supported by four bearers, leaving the Leader and one bearer spare at the head end. These two then climb carefully around the stretcher and take up positions at the foot (see FIG 76). The process is then repeated until the stretcher arrives on clear, solid ground. It is stressed that this operation of handling a stretcher in difficult conditions, calls for a high degree of team work and that the Leader must retain control throughout. He must ensure that while the stretcher is being passed, no member of the team is moving on the debris.

4.44 Using Four Bearers

In this case the operation is carried out in a similar manner, except that where with six bearers there were four men to support the stretcher, while two changed their positions to the foot --- now using only four bearers, two must support, whilst the other two move to the foot. It will be found of great assistance to those who are left supporting the stretcher, to get their thighs well braced under the strings. Not only does this relieve the weight on the bearers' arms, but also helps stabilise the operation.

4.45 Moving a Stretcher in Confined Spaces

In confined spaces, if there is sufficient height and the casualty has been lashed to the stretcher, it may be stood on end and by grasping the strings can be moved around sharp corners. Where the height is insufficient to permit this method being used, as in the case of shelters and basements etc, a compromise between the vertical and horizontal positions is necessary. The casualty should be carried feet first as far as the middle of the right-angled bend, when the foot of the stretcher is placed on the ground and the head end lifted as high as the ceiling will permit. The stretcher can be worked around the bend - one

bearer easing the foot end and the other the head. Under these conditions the stretcher should not be tipped on its side. To do so would only increase its height and also the difficulty in handling it.

4.46

PASSING A STRETCHER OVER A GAP

A large gap which has to be negotiated by bearers is probably best overcome by laying an extension ladder across it and, if possible, placing a decking of boards over the rungs. Shorter gaps, such as in floors etc, can be patched, using timber from the site or possibly the short ladder. Still smaller gaps can be traversed by the six or four-man stretcher parties in a similar way to that described for moving over debris.

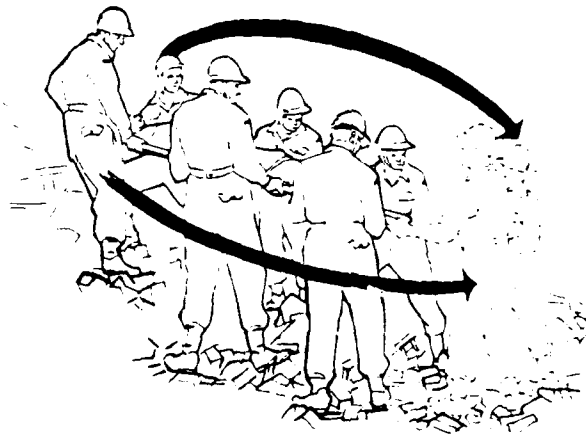


Fig 76

## CHAPTER 5

### LIFTING AND HAULING EQUIPMENT AND TECHNIQUES

#### 5.0 LEVERS

The purpose of all lifting or hauling devices is to gain sufficient power to lift or hold a large load with a small force, suitably applied. The simplest appliance for gaining this power is the lever. There are two principal ways in which a lever can be used, as illustrated in FIGURE 67a. In each case the advantage gained depends on the distance of (A), the centre of the load, and (C), the Point where the force is applied, from (B), the fulcrum.

#### 5.1 FULCRUM BLOCKS

A fulcrum should be of hardwood, never of brick or other crushable material. It must be resting on a firm base, which should be as large as practicable so as to distribute the weight to be lifted. The fulcrum must be placed as near to the weight as is possible under the circumstances, and it should not be placed at any point where there is a possibility of a casualty being buried immediately below. An appreciation must be made as always before using the lever to ensure the equipment is strong enough, as a collapse would, of course, be disastrous to a casualty.

#### 5.2 LIFTING

Power should be applied as near to the end as practicable. When more than one lever is used, the weight should be lifted evenly.

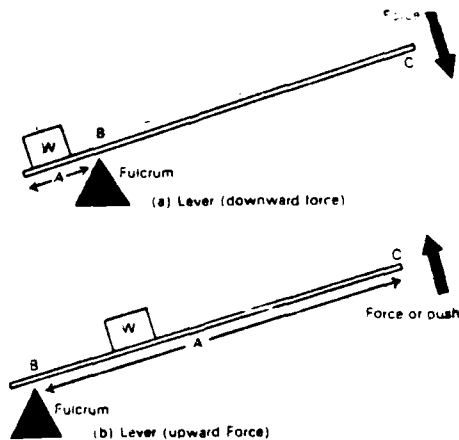


Fig 77.

5.3 HYDRAULIC RESCUE EQUIPMENT

In the past this technique has been carried out with either a heavy house lifting jack or a very heavy lever. The more modern practice is to employ the tremendous mechanical advantage, which is now available in the shape of a ram or one of two spreader attachments which can be coupled to a standard type of hydraulic pump. The power per weight of equipment can be readily appreciated by the fact that a pump and ram, weighing approximately 9 kg, can lift a load of 10 tonnes.

5.4 CONTENTS OF KIT

The typical hydraulic Rescue Kit consists of the following major items:

- 2 Hydraulic Pumps
- 2 lengths of pressure hose
- 2 rams of 10 tonnes capacity plus serrated saddles
- 2 screwed adaptors for ram plungers
- 1 wedge spreader
- 1 alligator spreader
- 2 flat base plates
- 2 ram toes
- 2 plunger toes

5.5 KIT OPTIONS - 20t lift and 5t pull rams, ram extension tubes

It will be noted that each set has two basic jacking units, ie, two pumps and two rams and the various fittings for each ram. In addition there are provided, one wedge spreader and one alligator spreader. This is because there will be a number of jobs where two jacks working simultaneously will have to be used, but relatively few occasions where two of the same type of spreader are required together.

5.6 METHOD OF OPERATIONS

The apparatus is operated by oil pressure from the pump through a hose to the ram and its accessories or to the spreaders. The various items comprising the kit can be connected or disconnected by finger-operated screw couplers. No tools are required. The rams and accessories can be used in any operating attitude, or even under water. When a lifting or spreading attachment has been coupled to the hose, power is applied simply by operating the hand lever on the pump.

NOTE: If undue force has to be applied to the operating handle when the ram or spreaders are near the end of their travel, cease pumping immediately otherwise damage to the equipment may occur. The pump has an inbuilt relief valve, but as explained below, unless the valve is changed to match the lighter loads,



protection is not available when lighter loads exceed permissible limits. Further, the valve will not blow when the ram plunger nears the end of its travel.

5.7

THE COMPONENTS

- a. Pump - Hand operated, normal working position flat on floor with foot on foot plate, can be used in any position except with the oil reservoir pointing downwards, ie, hose connection uppermost. Operating lever has metal clip to secure it in position so lever may be used as carrying handle.

On the right hand side of the pump is located the release valve. This must be tight when the load is being lifted and unscrewed a couple of turns when the time comes for the ram or spreader to be closed up. Lowering can be very finely adjusted by the use of this control. Inside the head of the pump there is located a blow-off valve, which is designed to release when the pressure in the system exceeds 68 900 kPa. As the area of ram base is almost 13 cm<sup>2</sup> this means that the ram will lift 9072 kg or almost 10 tonnes before the blow-off valve operates.

Thus ram and pump are well protected against overloading, but not so when using any toe configuration, the alligator spreader or the wedge spreader. These would require the relief valve on the pump to be changed, to one with a much lower relief pressure.

Obviously this cannot be done - the valve must be pre-set for maximum load, ie, 68 900 kPa.

It is therefore of great importance that the load of 5 tonnes using toes, 1 tonne using the alligator spreader and 750 kg on the wedge spreader should not be exceeded.

- b. Ram - This is simply a compact metal cylinder weighing about 2.3 kg, out of which extends a metal plunger when oil is pumped in under pressure. When closed up the overall height is 150 mm - full extension is 230 mm. Although this lift seems extremely small, it does enable the ram to be operated in very confined spaces initially, and by the normal process of packing as the operation proceeds, a 200 to 250 mm opening can be rapidly achieved. Using the ram itself on a vertical lift, 10 tonnes is the limit. If, however, the base plate and ram toe, or the plunger toe and ram toe are being used, a load of not more than 5 tonnes should be applied. This is because the load is being lifted on one side of the central axis and a bending movement is set up in the ram. This bending movement will distort the ram piston and may shear off the toe units, before the blow-off valve can operate.

- c. Other Rams - Other 10 tonne lifting rams in common use with S/TES rescue teams, have overall heights when closed up of 170mm and 400mm, providing lifting strokes of 50mm and 150mm respectively.
  - d. Hose - 1.8m or 2.0m lengths with a male coupler at one end and a female coupler at the other. Hoses are interchangeable and are pre-charged with oil ready for immediate use. A slight seepage of oil is of no consequence when couplings are being made or broken. Great care should be taken to ensure inner washers are not displaced or lost and that no dust or grit enters the system when coupling up.
  - e. The ram toe is a collar which screws on the top of the ram cylinder and has a lifting lug projecting from it. When used in conjunction with base plate, jacking can commence from an opening about 50 mm high, instead of the 150 mm required for the straight ram.
  - f. The plunger toe screws on to the screwed adaptor and when used with the ram toe, provides a very useful type of spreader.
- Experience will dictate which one of these many combinations is the correct one for the job.
- g. Wedge spreader - where clearances for operating the ram are nil, this wedge can be inserted after enlarging the opening with a wrecking bar or similar tool and then power applied to it with the pump. An initial lift of about 63mm can be achieved, but the weight at the tips of the wedge must not exceed 750kg.
  - h. Alligator spreader - This screws on to the top of the ram body and is an enlarged version of the wedge. When fitting, the serrated saddle is removed from the ram and the push rod of the alligator spreader inserted into the hole in the ram plunger. This is important. Check and see that it is so.

The alligator spreader is designed for use with the small 10 tonne rams with strokes of 50mm and 80mm. They **MUST NOT** be used with the high lift (150mm stroke) ram or the spreader will be seriously damaged.

When closed the spreader requires an opening of 32mm, but has a maximum opening of 305mm. The weight on the tips of the jaws should not exceed 1 tonne (or 1.5 tonne with some recent kits).

Some recent kits have included a 1.5 tonne alligator spreader with an integral cylinder. This does not have to be attached to a ram for operations.

#### 5.8 SPECIAL FEATURES OF THE EQUIPMENT

The entire kit is very light and portable, considering the fact that the two rams have a combined lifting capacity of 20 tonnes. The pump permits very selective control over lifting and lowering. The flexible hose allows the power tools (ram and spreaders) to be operated in a position, that may be inaccessible for normal type jacking equipment. It also allows the operator to keep well clear of the actual job. The ram and spreaders will work upside down, sideways, any way. They are still equally effective.

It is important to realise that the hydraulic rescue set is not only an extremely efficient lifter, but it is also just as effective a pusher. Important Note: The information detailed above refers to the portable hydraulic rescue equipment only. Should any other type of equipment be issued the same principles apply, however there may be some variation in the component parts and the method of operation.

IF ANY DOUBT EXISTS, ALWAYS REFER TO THE MAKER'S HANDBOOK FOR INFORMATION.

#### 5.9 SAFETY POINTS

- (i) The pump should only be operated with one hand and reasonable pressure.
- (ii) No extension should be fitted to pump handles for any reason.
- (iii) Pack as you jack.
- (iv) Couplings are vulnerable, particularly during spreading/cutting operations.
- (v) Hoses are vulnerable at all times.
- (vi) All components should be placed under full load test, on a monthly basis to maintain the integrity and flexibility of the seals.

#### 5.10 MAINTENANCE

Oil check - From time to time the oil level in the pump should be checked. This is done by holding the pump vertically and removing the screw at the rear of the oil reservoir. A dip stick is attached to the screw and if necessary oil should be added to bring the level up to the notch on the stick. NOTE: Only good quality hydraulic jack oil should be used for topping up. Hydraulic brake fluid or engine oil should not

be used. In cases of extreme emergency, however, any non-viscous liquid can be used, eg, SAE 10 motor oil or even water. If this has occurred, the entire system should be drained at the earliest opportunity.

- 5.11 AIR IN THE SYSTEM - Should air get into the system it will not function effectively. Difficulty will be encountered in getting the ram or spreaders to extend or hold their extended position. Air should be expelled in the following way:

- a. Connect ram to pump and fully extend it.
- b. Open release valve.
- c. Invert ram and push down on plunger until fully collapsed.
- d. Close release valve.
- e. With pump vertical (hose end downwards) give 3 to 12 rapid strokes. Repeat the procedure, if necessary.

- 5.12 BLANK CAPS - Whenever any item of the kit is not in use, the blank cap should be screwed into the coupler to protect the valves from dirt and grit.

- 5.13 ACCESSORIES - Apart from keeping all screw threads clean and oiling the moving parts of the wedge and alligator spreaders, no maintenance is called for.

- 5.14 JACKS

If hydraulic equipment is not available, provision must be made for jacks. Two types of manual jack are in common use.

- a. The Ratchet or Wallaby Jack (Figure 78)

This is a simple jack which raises a load by means of a lever, working against a ratchet, which supports the load between each lifting stroke of the lever.

These jacks come in a variety of sizes and lifting capacities with the 2, 5 and 20 tonne capacity jacks in common use with Emergency Services.

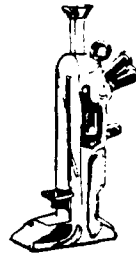


Fig 78.

b. The Screw Jack (Figure 79)

A simple jack operated by means of a lever which rotates a screw jack, is probably the safest type since all danger of slip-back is eliminated.

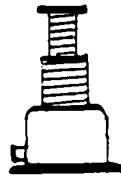


Fig 79.

5.15

RULES FOR THE USE OF JACKS

For safe and efficient use of jacks, the following rules should be observed:

- a. Under a load, a jack should stand squarely on a heavy timber or other substantial footing, to prevent its slipping or sinking into the ground. The footing must be dry and free from grease, so the jack will not slip.
- b. As the weight is lifted, solid material supports should be placed under it to prevent damage should the jack collapse. Pack as you jack. The weight of raised sections of walls and floors, should not be allowed to rest entirely on the jack while rescue workers crawl under. CRIBS should be set under heavy loads or sections of floors, to prevent settling after the lifting operation is complete. Cribbing can be done with timbers of various sizes from 600mm to 3m in length, depending on the weight to be supported and available working space.

Be sure that the ground is level at the point where the crib is to be set. It is better to level off high spots than to fill low ones.

The crosstie Crib FIGURE 80 is a safe method of supporting heavy weights. Space several timbers well apart and parallel, then place a second level of timbers on top and at right angles to the first layer. Each added layer is at right angles to the previous layer. The number of layers needed will depend on how high the load is to be lifted.

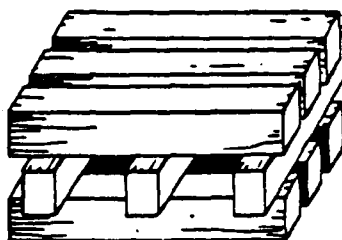


Fig 80.

- c. Jacks should be inspected and tested regularly. They should be kept clean, with working parts well oiled and greased.
- d. When using several jacks under one load, be sure all jacks lift or lower together so that the load will not tip, nor put too much weight on one jack.
- e. When jacking a metal object, be sure that a wooden plank is placed between the jack and the object to prevent slipping.
- f. Be sure the 'up' and 'down' latch panels are not cracked on ratchet jacks.
- g. Be sure the jack handle fits the handle socket.
- h. Always remove the jack handle when not in use.
- i. Since the base of a jack is comparatively small, always use a base board to obtain a greater bearing surface.

#### 5.16

##### ANCHORAGE

Anchors and holdfasts are used in rescue for the purpose of securing a line, rope, wire or chain which will be under strain. They will fall into three main classes:

- a. Natural: Trees and boulders.
- b. Constructed: Those which have to be set up, eg, by use of pickets and lashings or buried baulks of timber.
- c. Improvised: Those found on the site, eg, reinforced concrete or metal standards, metal framework of buildings, baulks of timber across door openings, etc.

5.17 PRECAUTIONS

In using any type of anchor care must be taken to pack it in such a manner as to prevent chafing, usually by means of sacking wrapped round the holdfast when it is proposed to use a fibre or wire rope. Pickets should be of sound materials, if possible of steel. In most cases 1.5m is a suitable length, with a diameter of 25mm or more, hardwood 80mm and softwood more than 100mm.

5.18 Natural Anchors

The most readily identifiable anchor points are trees and large rocks or spikes of rock. These must be carefully selected, trees with sound root systems, well stabilised boulders, and so forth. These points should not be too close to risk areas, and must be tested by a hauling crew before use.

Anchor points can be re-inforced by:

- a. Use of pickets and lashings, if the pickets can be driven into the ground.
- b. Lashing to a vehicle bull-bar, if the vehicle can be brought to close proximity with the tree.
- c. Securing the rope to a primary strong point and passing a turn of the rope around secondary trees, preferably maintaining as straight a line as possible.
- d. Using polyamide tape attached to several trees and leading to a central point can work well if none of the individual trees will support the load. Ensure that the angle made by the tapes from the central point, preferably does not exceed 45 degrees.

LOAD INCREASES RELATIVE TO ACUTENESS OF ANGLE.

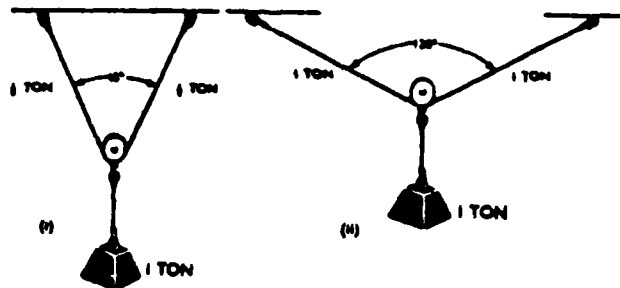


Fig 81.

5.19

#### PICKET HOLDFASTS

In ordinary soil, pickets are suitable as holdfasts for strains up to 2 tonnes. They may be used as single pickets or, when formed into a holdfast, may be arranged as 1 and 1; 2 and 1; 3, 2 and 1, according to need. The following points should be observed:

- a. The pickets should be driven into the ground as close as possible to an angle of 45°, away from the line of pull, with two-thirds of their length into the ground. The strongest picket should be nearest the weight of the load being taken.
- b. The lashings connecting the pickets should be at 90° to the pickets and should go from the head of the one in front to ground level on the one behind. This determines the distance between the pickets, which should never be less than 1 m apart.
- c. Since the weakest part of the rig in use is normally at the holdfast, a man should be stationed to watch this as it may give early indication of overloading or of excessive strain on the guy.
- d. As a rough guide to safe working loads a 1.5m x 25mm mild steel picket properly driven into the ground with good holding qualities will safely support a load of 350 kg.

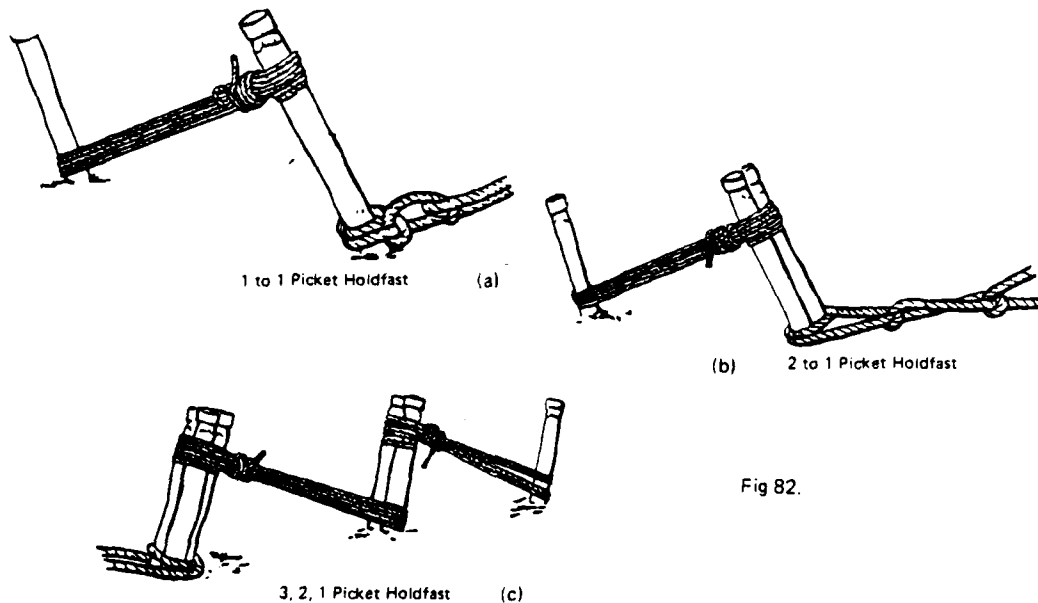
As the number of pickets in the holdfast is increased so the weight it will support is increased by 350 kg for each picket.

NOTE: This guide is so dependant upon the state of the ground into which the pickets are driven that it must not be thought of as a rule. As stated, it is a rough guide and should always be used as such.



5.20 PICKET LASHINGS (Figure 92)

The lashing should be started by a clove hitch with 12mm lashings about 180mm from the head of the front picket. Four turns should be taken around the backing-up picket and the head of the front picket, placing these above the close hitch. Frapping turns should be applied around the lashing, finishing off with a clove hitch around the lashing, thus using up whatever spare rope is left. The lashing must be tightened before commencing the frapping turns.



5.21 BURIED HOLDFASTS (Figure 83)

With this type, a good stout piece of timber, a length of steel girder, a large diameter water pipe or a vehicle spare wheel is required. A trench is dug to accommodate the material used and a small outlet made at right angles to the trench to allow the rope or wire to come to the surface. The greater the load to be applied the deeper the trench should be. It must be appreciated that the buried holdfast is only satisfactory where the angle contained between ground level and the rope is small. This being the case the trench need not be filled in but a man should be detailed to check the holdfast when the initial load is applied.

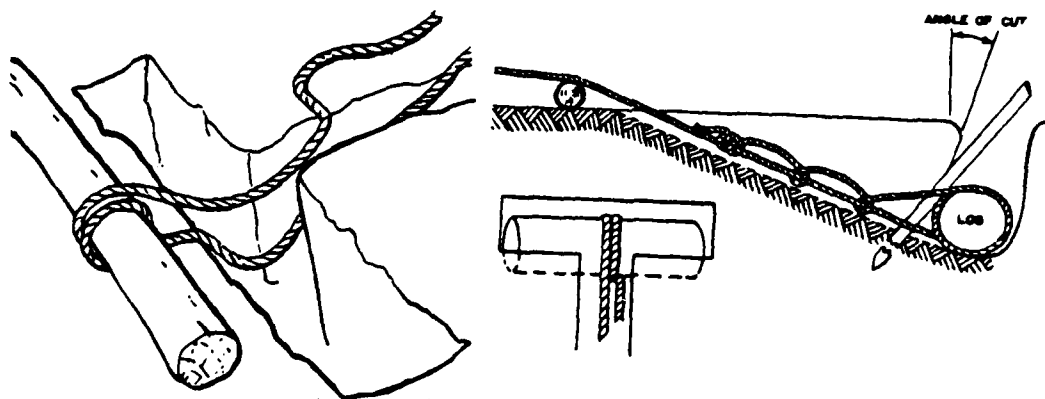


Fig 83.

5.22

LOG AND PICKET HOLDFAST

As in Figure 84, drive in four pickets about 40-50 cm apart. Drive in a second row of four pickets 1.5 to 2m behind the first row. Lay a log of sufficient size for the job at hand, behind the first row of pickets. Make four to six turns around corresponding first and second row pickets going from the top of the first to the bottom of the second.

Pass a sharpened stick through the turns of the lashing line, between each pair of pickets and twist until the lashing is taut; then drive the stick into the ground.

This method is of particular use in wet or soft earth since the log acts as a beam and bears evenly against the front row of pickets.

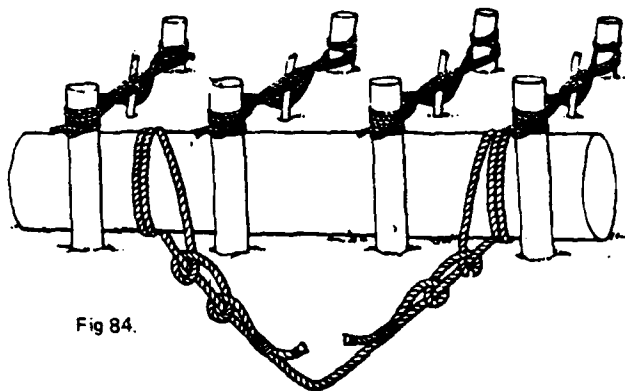


Fig 84.

5.23 IMPROVISED HOLDFASTS

When using an improvised holdfast, eg, an electric light pole, a baulk of timber across a doorway or a heavy vehicle, etc, care should be exercised in assessing whether or not the item selected will in fact carry the load; and secondly that it is correctly placed relative to the rig which is being erected. Badly placed holdfasts can seriously jeopardise the success of any rescue operation in which they are used.

5.24 BLOCKS

- a. Blocks are used in rescue for the purpose of changing the direction of ropes and for gaining power, when lifting or hauling weights which may be trapping a person or blocking an entrance to a basement, etc.
- b. If a Tirfor is not available, provision should be made for blocks, 1 three sheave, 1 two sheave, and 1 snatch block suitable for use with the 24mm or 16mm fibre ropes.
- c. The snatch block differs from the others in design and is a single-sheaved block with an opening in one side of the cheek or shell and strap so that a rope can be engaged or 'snatched' on the sheave without the end having to be reeved through as may be necessary, for example, when the ends of the rope are secured or inaccessible. This opening is closed by a hinged or pivoted portion of the strap.
- d. Sheave size and shape are important to safety. The diameter of the sheave must be such that rope is not turned too sharply, and particularly with steel wire ropes, the shape of the sheave groove must be the correct width and depth for the rope.

A groove of incorrect size can seriously damage any rope reeved over it, and attention must be paid to sheave selection. In very basic terms, sheaves with narrow and deep grooves are for use with SWR, while cordage sheaves have wider and shallower grooves.

Sheave Selection

Groove too large



Causes flattening of rope.

Groove too small



Causes pinching and abrasion of rope.

Fig 85.

5.25 TACKLE

- a. A tackle is formed by reeving rope through two blocks and is used in rescue work for:

- (1) lifting a load
- (2) hauling a load.

- b. The following terms are used in connection with a tackle:

Reeving - The operation of passing the rope round the sheaves of the blocks.

Standing end - the part of the rope which is 'made fast' to the becket of a block.

Hauling part - the free end of the fall or rope to which the power is applied.

Returns - The ropes between the blocks.

To overhaul - To lengthen the distance between the blocks by adjusting the tackle to the required length.

To round in - To bring the blocks closer together.

Chock-a-block - When a tackle is chock-a-block the blocks are as close as they can possibly go (approximately 1.5m with blocks which will take a 24mm rope).

5.26 REEVING TACKLE (Figure 86)

To 'reeve' a tackle, two men should stand back to back about 2m apart, with the blocks slightly in front of them between their feet and the hooks pointing outward. The coil of rope should be to the left of the top block for lifting tackle, ie, the three-sheave block for the 3/2 tackle. The first man should reeve the standing end of the rope through the lowest sheave of the top block, then pass it to the second man who will reeve it through the lowest sheave of the second block.

The rope should be passed successively through the sheaves of both blocks from left to right and finally made fast to the becket of the second block by two half hitches. The running end should be secured to prevent it from slipping.

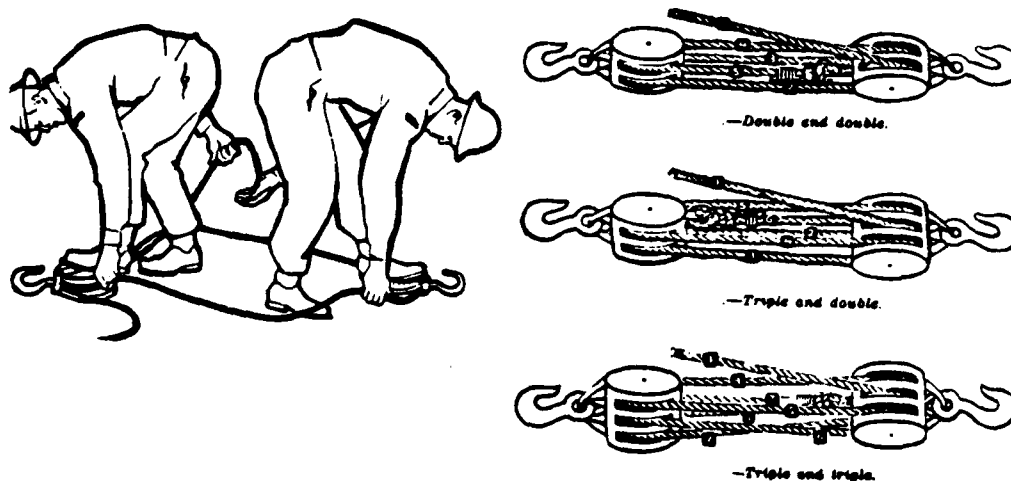


Fig 86.

#### 5.27 TYPES OF TACKLE

When referring to a particular tackle the following terms are used:

3 and 2 tackle (light gin tackle) - three-sheave block and a two-sheave block.

2 and 2 tackle (gun or double luff tackle) - a two-sheave block with a two-sheave block.

NOTE: 'Jinny Wheel', or single-sheave block, commonly used by builders for hauling up or lowering material, is not used in rescue but a similar rig can be made using the snatch block.

The tackle most commonly used in rescue is the 3 and a 2, using the three-sheave block and two-sheave block provided in each set of equipment, if no Tirfor is supplied.

The snatch block is used with derricks, sheets and gins to allow change of direction of the rope and facilitate hauling.

Using the 24mm fibre rope and the 2 and 2 tackle, the following maximum loads can be dealt with:

- (a) Lifting 1500 kg
- (b) Hauling 1800 kg

The maximum distance a weight can be moved with this tackle is 8m with the 60m rope and 20m with the 125m rope.

5.28 LIFTING TACKLE

A lifting tackle has the load attached to the running block (the lower block) and the hauling part of the fall coming off the standing block (or upper block).

5.29 HAULING TACKLE

A hauling tackle is one in which the hauling part of the fall comes off the running block to which the load being hauled is attached. The standing block is made fast to a holdfast, or otherwise anchored.

STRENGTH OF TACKLE

5.30 LIFTING TACKLE

When calculating the capabilities of a lifting tackle it must first be realised that only the returns between the blocks are assisting to lift the weight and that the running end is not helping in the lifting. The power is exerted directly on it and in the opposite direction to that in which the weight is moving.

Factors to be taken into consideration in calculating the strength of a lifting tackle are:

- a. The SWL of a rope  $\frac{D^2}{100}$  in kN or  $D^2$  in kg.
- b. The number of returns at the moving block (including the running end if it is made fast to the moving block).
- c. The loss of efficiency of the tackle owing to friction. One-third reduction allowed.

Example - Using a 3 and 2 tackle reeved with a 24mm rope.

(SWL of rope) x (Returns at moving block) x  $\frac{2}{3}$  (Friction Loss)

Which is $\frac{24^2}{100} \times 5 \times \frac{2}{3}$	or $24^2 \times 5 \times \frac{2}{3}$
$= \frac{576}{100} \times 5 \times \frac{2}{3}$	$= 576 \times 5 \times \frac{2}{3}$
$= 19.2 \text{ kN}$	$= 1920 \text{ kg}$

#### 5.31 HAULING TACKLE

When calculating the strength of a hauling tackle it must be remembered that the hauling part of the all is pulled in the same direction as the weight to be moved and assists the returns to move the weight. The hauling part must therefore be included in the calculation assessing the number of returns at the moving block.

All other considerations in assessing the strength of a hauling tackle are exactly the same as for a lifting tackle.

Example - Using a 3 and a 2 tackle reeved with a 24 mm fibre rope.

(SWL of rope) x (returns at moving block plus hauling part) x  $\frac{2}{3}$

which is $\frac{24^2}{100} \times 6 \times \frac{2}{3}$	or $24^2 \times 6 \times \frac{2}{3}$
$= \frac{576}{100} \times 6 \times \frac{2}{3}$	$= 576 \times 6 \times \frac{2}{3}$
$= 23 \text{ kN}$	$= 2300 \text{ kg}$

#### 5.32 LENGTH OF ROPE REQUIRED FOR A TACKLE

The longest length of rope carried on a rescue vehicle is usually 125m. It is therefore necessary to know:

- The maximum length of tackle that can be reeved with this rope.
- How to calculate the length of rope required for a tackle that will move a weight through any given distance.

The factors to be taken into consideration for calculating the length of rope required in a tackle are:

- a. The number of returns between the blocks plus the hauling part. (This is quickly assessed by counting the total number of sheaves in the blocks and adding one for the rope required as the hauling part).
- b. The distance that the weight has to be moved either vertically or horizontally.
- c. The overall length of a tackle when chock-a-block. (Normally a constant of 1.5m when measured from hook to hook).

Example - It is necessary to move a mass through a distance of 14 metres by means of a 3 and a 2 tackle. To find the length of rope required:

(No. of sheaves plus 1) x (Distance to be moved plus chock-a-block)

$$(5 \text{ plus } 1) \times 14 + 1.5$$

$$6 \times 14 + 1.5$$

$$= 85.5 \text{ metres}$$

Length of rope required.

#### 5.33 ANTI-TWISTERS (Figure 87)

A tackle when loaded is sometimes liable to twist and thus cause much additional friction between the returns. In most cases this can be overcome by preventing the load being lifted from turning, ie, attaching guide lines to the load. In some cases, however, the tackle may still twist owing to the blocks turning between the swivel hooks. If this happens the load should be lowered and an anti-twister inserted above the becket on the lower block. A pick handle or similar piece of timber is about the size required, and is slid in above the becket and under the two half hitches securing the running end of the rope to the lower block. Guide lines are then clove hitched to each end of the pick handle so that the anti-twister can be manipulated well clear of the lifting operations.

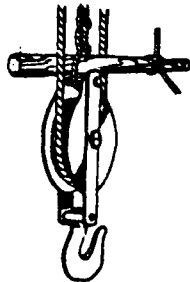


Fig 87.



5.34 TACKLE OPERATIONS

The following points should be observed when using tackle:

- a. The rope must be free from kinks and twists and run evenly over the sheaves.
- b. All fastenings must be securely made.
- c. Tackle should be carried, not dragged along the ground.
- d. Suspended weight should be eased off uniformly and not by jerks.
- e. Men should be trained to pull together. On the command 'Take up the slack' they should haul in the slack ready to take the load.
- f. All blocks should be moused.
- g. Careful consideration should be given to anchor points so as to ensure they are capable of withstanding the force to be applied.
- h. Snatch or single-sheave blocks should be used wherever possible as "leading blocks" to change the direction of haul to the horizontal plane so as to maximise hauling efficiency.

On the command 'Heave', the crew should heave and hold the rope they get. To ensure easy and steady operation the men should be positioned on alternate sides of the rope so as to keep the pull in a straight line.

- i. The returns near the blocks should not be touched when moving unless absolutely necessary and then only those moving away from the block.
- j. Not more than one tackle should be hooked in the same sling.
- k. Blocks should be well cared for, carefully handled and kept free from dirt and grit with working parts sufficiently oiled to ensure free and easy working.

5.35 DERRICKS - SHEERS - GYNS

It may be necessary to rig one or all of these, and all rescue personnel should be trained in their erection.

In choosing poles for such apparatus, it is important to ensure that they are long and strong enough to permit the load to be lifted to the required height after allowance has been made for the length of the tackle when chock-a-block plus the length of the

sling or chain use, the height of the object to be lifted, and, with sheer legs and gins, additional allowance must be made for the slope of the legs.

5.36 STANDING DERRICK (Figure 88)

A standing derrick is a single spar or pole (or two or more lashed together for strength) with the butt on the ground or on a solepiece, and the pole held vertical by three, or sometimes four, guys. The weight can be lifted and moved to the right or left and to the front, but only to a limited distance.

To support the lifting tackle and to prevent it from binding on the derrick pole, a short crosstree (or cross head) about 500 mm long is affixed to the derrick pole by a square lashing with a 12 m lashing.

The crosstree should not be shouldered or bolted to the upright, as this weakens both crosstree and derrick pole. Its normal position is from 450mm to 600mm from the top of the pole, but in all cases it is advisable to have it fixed as far down the pole as will give sufficient room to lift the weight the required distance.

With any particular pole the shorter the length of pole bearing the load, the greater the load it can carry within the limits imposed by the type and size of pole in use.

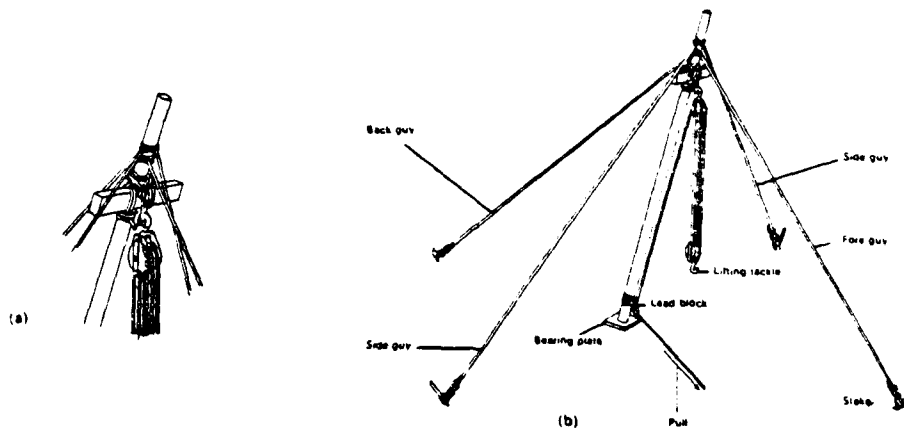


Fig 88.

16mm rope is the minimum safe standard for all guy ropes, and where long rope lengths are used, they should be attached to the top of the pole by a clove hitch made in the centre of the rope. If it is impossible under certain circumstances to use a guy rope, a 'lazy leg' may be used. This is done by lashing another pole to the pole of the derrick, using the diagonal lashing. (Figure 89)

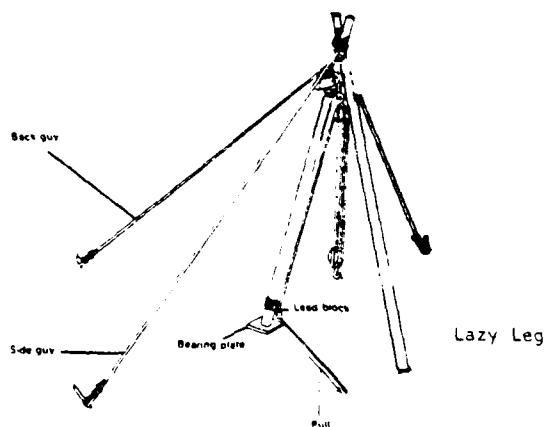


Fig 89.

**Anchors** - The distance of the guy anchors from the foot of the derrick should be equal to twice the height of the derrick if possible, but never less than the height of the derrick. Where conditions are unsuitable for the use of pickets, improvised holdfasts may be used.

**Head Rigging** - If a Tirfor is being used to lift the load, then all that is required at the crosstree is a snatch block, through which is passed the Tirfor wire. Normally the block is secured with a 10 mm chain. Both block and chain hook must be moused.

**Leading Block** - To ensure that the load is supported down through the axis of the derrick, a leading block should be lashed to the foot of the pole, and the hauling rope directed through the block. (Figure 89)

**Footing** - The ground on which the derrick will stand must be firm or steps must be taken to make it so. It is advisable to form a shallow hole into which the butt will be placed. If the ground is too soft to withstand the pressure of the butt, a footing of baulks of timber may be necessary, so constructed as to spread the load over a sufficiently large area of ground. Care must also be taken to prevent 'kickback' particularly when luffing (para 5.39) by restraining the heel with lashings on firm ground or placing the heel in a hole approximately 30 cm deep on softer ground.

5.37 LAYOUT AND PREPARATION

Having chosen the position for the foot of the derrick, allowing for any necessary luffing, the points at which guy pickets will be driven in should be selected. After preparing the derrick, the tackle should be overhauled to the required length and the lower block temporarily lashed to the pole to prevent swinging during erection.

5.38 RAISING

The initial raising is done by hand under the leader's direction. The guy at each picket is controlled by a man and as the pole is raised the slack on the fore guy is taken in. During erection the guys are temporarily controlled with a round turn on the pickets and finally made fast with a round turn and two half hitches.

5.39 LUFFING

When raising a stretcher or weight over an obstruction, such as a wall, it is usually necessary to luff the pole slightly. When this is being done each guy line must be controlled under the direction of the leader. Since the men must work in unison the leader must give precise directions to haul or slacken, and must not leave the men to exercise their own judgement, otherwise misunderstandings may occur and lead to an accident. The maximum luff at any time the derrick is in use must not exceed one-third of the height of the derrick, while the initial luff angle is one fifth of derrick height. This limit of incline fixes the distance at which a weight can be picked up.

5.40 SHEER LEGS (Figure 90)

Description - Sheer legs consist of two poles with their butts on the ground and their tops lashed together and held in the air by a fore and back guy, forming an inverted 'V'.

Sheer legs can sometimes be employed where the use of a derrick would be impracticable, but can only be used to move the weight in a straight line by swinging the load between the legs. For a given load, the two spars may be lighter than the one required for a standing derrick.

NOTE: For safety reasons, 16mm rope is the minimum diameter rope to be employed for guy lines.

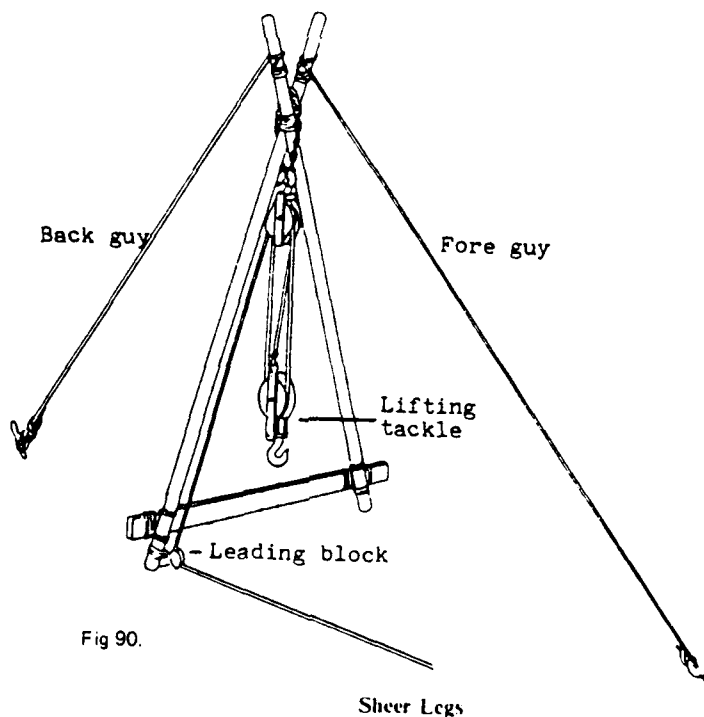
5.41

LAYOUT AND PREPARATION

Two poles should be selected as nearly of equal length as possible, and laid with their butts flush together on the ground, the tips being raised to a convenient height for working. Spacing pieces 50 mm to 75 mm thick should be inserted between the poles and the latter lashed with a round lashing. The butts of the poles should be opened up until their distance apart is about one-third of the length from butt to lashing. To prevent the butts from splaying, a ledger should be lashed on near the butts, or as an alternative a 12m lashing can be used, fastening it to each leg by a round turn and two half hitches, or pickets can be driven in and fastened to each leg. A sling or strop (ie, a short length of heavy rope or chain) should be passed over the fork or crutch so that it will rest across the poles and not in the lashing between them. The lifting tackle is prepared and hooked into the sling, the lashing being suitable protected with padding. The Hook must be moused.

Guy line anchors should be placed at a distance of not less than twice the height of the sheerlegs from its base.

The distance at the base of the frame where the ledger is secured should be no more than one-third of the height of the poles. The ledger should be secured as close as practical to the base of the poles, allowing for ground surface.



Guys - The guys are similar to those required for a derrick but consist of two only, a fore and back guy of 16mm minimum diameter. They should be made fast above the round lashing by clove hitches in such a way that they will draw the spars together when the stress comes on to them, ie, the fore guy to the rear pole and back guy to the front pole. The length of the guys is similar to those used with a derrick. In certain circumstances a 'lazy leg' can be used instead of a guy.

Tackle - A sling or strop is passed over the crutch to take the hook of the upper block of the lifting tackle. The hook must be moused. The tackle is prepared to the required length, and the lower block is temporarily lashed to one of the poles to prevent swinging during erection.

Pole butts should be dug into the ground to prevent kickback and the hook should be moused.

5.42 RAISING

The initial raising is done by hand under the leader's direction. The guy at each picket is controlled by a man and, as the sheer legs are raised, the slack on the fore guy is taken in. During erection the guys are temporarily controlled with a round turn on the pickets and finally made fast with a round turn and two half hitches. The butt must be placed sufficiently far from any obstruction to permit the top of the sheer legs to be luffed over it.

5.43 LUFFING

A sheer leg is luffed by carefully paying out on one guy and taking in on the other. All men must work in unison under the leader's direction to ensure sound operation and prevent accidents. The amount of luff permissible is similar to that allowed in derricks, ie, initial luff one-fifth, thereafter one-third of vertical height of rig.

5.44 GYNs OR TRIPODS (Figure 91)

Description - A gyn or tripod consists of three poles lashed together near the tips and with the butts forming an equilateral triangle on the ground. No guys are required and the space occupied is small, but only a vertical lift is possible. The lifting tackle is suspended from a sling passed over the crook formed by the tips of the spars. The poles used should preferably be of equal length and strength.

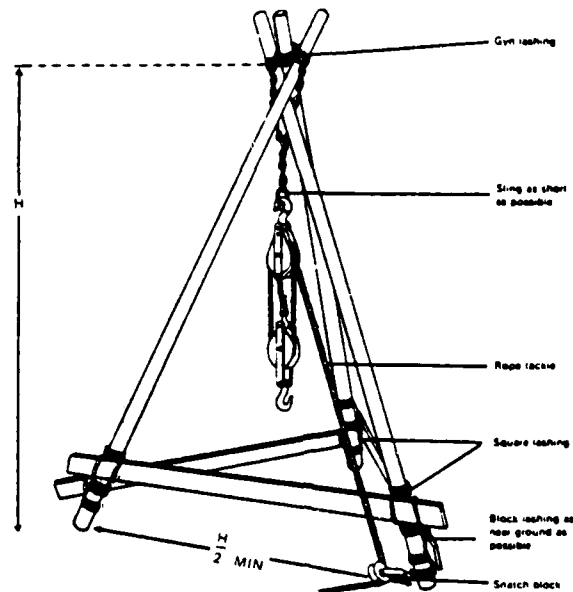


Fig 91.

5.45

#### LAYOUT AND PREPARATION

The three poles should be laid out side by side, the butts flush on the ground and the tops raised on a trestle or box. Having placed them they should be marked about 1 m down from the tip of the shortest pole to show the position of the centre of the lashing. The centre pole should now be removed and reversed with its butt on the ground on the opposite side of the trestle. All three marks should be in line. Spacing pieces, ie, 50 mm to 75 mm thick according to the diameter of the poles should be inserted between the poles, after which they are lashed together with a figure-of-eight lashing. The spacer blocks are then removed and the two outer poles are crossed until their butts are at a distance apart equal to about half the effective length of the poles, the top of the centre pole to rest in the crook of the other two.

5.46

TACKLE - A sling or strop, ie, a short strop of heavy rope or chain, is placed in the crutch in such a manner as to bind together when the weight is taken, the lashing being suitably protected. The hook of the upper block is hooked into the sling and moused. The tackle is prepared and over-hauled to the required length. The lower block is temporarily lashed to one of the legs to prevent swinging during erection.

5.47      RAISING

The head of the gyn should be lifted as far as possible by hand and the centre pole brought in to form an equilateral triangle. The butts should be evenly spaced at a distance apart equal to about half the height from the butt to the lashing, they must all be on the same level or the weight will be distributed unevenly, and the gyn must be placed so that its head is as nearly as possible over the centre of gravity of the load.

NOTE: Whether a weight is suspended or not, the gyn should not be left standing unless the butts are secured against slipping by one of the methods used in the sheer legs.

5.48      TIRFOR WINCH      (Figure 92)

The appliance consists of a machine or casing through which passes a long steel cable which is attached to the load to be hauled or lifted. The operation of a lever handle backwards and forwards pulls the cable through the machine, which, if properly anchored, causes the load to be hauled towards the machine.

The equipment consists of:

- a.    A pulling and lifting unit complete with a swivel hook to enable it to be secured.
- b.    A detachable telescopic tubular steel handle for operating the unit.
- c.    A length of flexible steel wire rope 18m long, 11mm in diameter, fitted with a hook at one end, the other end being tapered and fused. This rope is coiled on to a reeler for convenience in carriage.

The machine unit consists of a steel casing enclosing two pairs of automatic jaws which grip the cable passing through the casing. These two pairs of jaws are moved in opposite directions by means of linkage when the handle is operated backwards and forwards. This alternating operation of the handle results in a hauling or lifting movement of the cable of about 70 mm for each complete forward and backward stroke of the lever, which with normal operation on a light load results in a travel of about 4 metres per minute. The unit provides a mechanical advantage of 1.43. Its size is 610 mm x 305 mm x 152 mm and its mass 17.7 kg. Its SWL (safe working load) capacity is: pulling up to 1.5 tonnes, lifting up to 1 tonne.



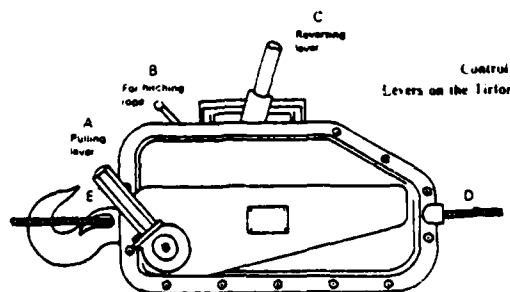


Fig 92.

5.49

#### REVERSE OR LOWERING MOVEMENT

By transferring the operating handle to the level on the top of the casing, a reversing action is obtained. This passes the cable through the machine in the opposite direction and enables the load to be lowered. The cable is under constant tension while the load is on it and does not jerk or slip during the lowering. Any jerky movement will be due to lack of lubrication, a fault which should be rectified immediately.

The following operating instructions are those issued by the manufacturers of the machine:

- a. Pull clutch lever (B) firmly towards hook on machine, until it is seated in the notch.
- b. Push the rope into the machine at (D) until it protrudes through the hole in the hook at (E).
- c. Pull the rope through the machine until the desired length is reached.
- d. Place clutch lever (B) back into the operating position - this is done by lifting the lever out of the notch and allowing the spring inside the machine to carry it into its operating position.
- e. The rope is now firmly gripped in the jaws of the machine. To pull the rope through the machine, place telescopic operating handle on pulling lever (A) and move it along the direction of the rope. The rope moves through the machine on both forward and backward strokes of the lever.
- f. To reverse rope through the machine, remove the telescopic handle from (A) and place it on reversing lever (C) and move it again in the direction of the rope. The rope is paid backwards through the machine on both strokes of the lever.

- g. To remove rope, pull lever (B) towards hook as in (a) and pull rope through the machine.
- h. If the operator cannot remove the load with the telescopic operating handle fully extended, the load is too great for the machine, and the snatch block supplied should be used to increase the machine's power.
- i. Always use slings and anchors of sufficient strength to withstand the load.
- j. Keep the wire rope wound on to the reeler when not in use.
- k. Never allow any kinks in the rope to enter the machine as this causes internal damage.
- l. Only use the wire rope supplied with the machine.
- m. Do not leave the rope release lever (B) in its release position when the machine is not in use, as this will shorten the life of the springs.
- n. Never operate A and C at the same time as this will cause internal strain.
- o. Never anchor the machine by the tip of the hook, always use a sling.
- p. Never apply tension to the running end of the rope.
- q. Never step or stand over a wire rope under tension, and remain clear of the likely whip back areas should the rope break.

5.50

LUBRICATION

- a. Heavy gear oil should be poured into the slot at the top of the machine. The machine should then be shaken to allow the oil to reach all working parts, the surplus oil being drained off through the rope holes.
- b. Oil regularly through the oil holes which are situated on both sides of the lever shaft A.

5.51

MAINTENANCE

- a. Before using the machine.
  - (1) Check wire rope to see that it is free of kinks and broken wire. Never use a damaged rope as this jams inside the machine.

- (2) Put rope in a machine and move it to and fro with levers A and B; this movement should be easy and free from jerks.
- (3) Make sure that the machine is lubricated correctly.
- b. When using the machine.
  - (1) Should the machine become filled with dirt or dust from the debris, it must be immersed in a bath of kerosene and shaken well. This operation must be repeated until the dirt or debris dust is removed. The machine must be well lubricated before use.
  - (2) Should the machine become jammed with small pieces of debris or dust, the casing bolts must be removed and one half of the casing should be lifted off. The debris or dirt can then be scraped out of the machine. When the casing is replaced ensure that the cross bar on the spring tubes always fits properly into the slots on both casings. This can be done by looping a piece of wire round the bar and holding it in position until the bolts are fitted. Make sure that all nuts and bolts are replaced and properly tightened.
  - (3) Should the motion become jerky when lowering, this is due to lack of lubrication and the machine should be oiled immediately.
- c. After using the machine the wire rope must be cleared and coiled back on to the rope reeler.
- d. Examinations at monthly intervals (Figure 93)
  - (1) Check for wear or misuse.
  - (2) Make sure that the rope hook is properly fastened on the rope.
  - (3) Measure distance (x) on the rope hook and anchoring hook; if it is more than 70mm the hook has been strained and should be replaced.
  - (4) Make sure that the nuts and bolts on the casing are fitted and properly tightened.

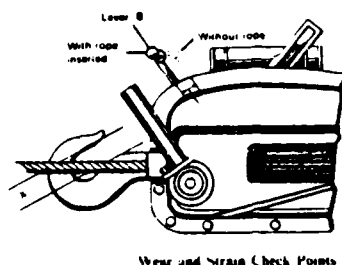


Fig 93.

e. Monthly check on wear of machine jaws.

- (1) Remove wire rope from machine and let the release lever (B) return to its normal position.
- (2) Mark this position on the casing.
- (3) Pull lever (B) forward into its groove, and feed rope into the machine.
- (4) Return lever (B) to its normal position with the rope in the machine, as though the machine was about to be used.
- (5) Mark the new position of lever (B) on the casing.
- (6) There will now be two marks on the casing. The distance between these should never be less than 13 mm; if less, if it is a sign of excessive wear on the jaws and these should be replaced.

5.52

OPERATIONAL USES

As a device for lifting or hauling, the machine has innumerable uses and applications. Being light and compact, it can be attached to any convenient holdfast or hung from overhead beams, or girders, slung from or attached to derricks or sheer legs, or even attached to the load itself if the cable end is anchored to a immovable object.

The 18m cable enables the load to be lifted, lowered or hauled considerable distances without changing the position of the machine, and, in conjunction with the S.W.R. blocks, permits the most convenient position to be selected for fastening the machine, while the rope can be taken over the pulleys, through window or door

openings, or down through floors to wherever the load may be. It can also be passed over a block at the head of a derrick or sheerlegs, to obtain height for raising loads such as blocks for masonry or for erecting tall poles or posts.

5.53 ANCHORING THE MACHINE

The efficiency and indeed the safety of all these applications of the hauling and lifting machine, depends upon the security of the anchorage or holdfast. This may be anything sufficiently strong or immovable, but it must be firm enough not to show any signs of failure under load.

Secured near the base of stout posts, lamp standards, stanchions, bollards, etc., by means of wire bonds, the machine should be able to haul in its cable and move, lift or lower its load without fear of sudden failure.

5.54 SAFETY FEATURES

The machine has three safety features incorporated in its design.

- a. The clutch lever (B) cannot be engaged whilst the machine is under load.
- b. If the strain on the lifting lever becomes too much for one man, it can be assumed that the machine has reached its safe working limit.
- c. If the safe working limit of the machine is exceeded, there are three sheer pins in the shaft of pulling lever (A). If rope and machine are in good condition, these pins will fail before more serious damage can occur. Spare sheer pins should be carried in the hollow handle of the machine. No special tools are required for replacement. The new pins are inserted, the load immediately eased, and blocks added to the system for greater advantage.

5.55 THE COME-A-LONG HAND WINCH

This low cost, readily available, hand operated winch, is a useful supplementary tool for the rescue team, but should not be viewed as a replacement for the Tirfor Winch.

The winch has a handle which cranks a drum via a pawl and ratchet system, thus winding the wire on to the drum. Forward and reverse are achieved by a spring loaded control of the pawl. The wire rope is normally around six metres in length and the winch has a single pull capacity of up to 600 kg.

5.56 VEHICLE MOUNTED POWERED WINCHES

The powered winch, be it 'electric' or 'power take off', is a powerful and versatile tool which can be used for hauling. The machines are available in many forms and each type has its own operating procedures. Therefore read the manufacture instruction's before you need to use it.

5.57 BASIC SAFETY RULES

- a. Always be aware of the maker specifications for safe working loads and operate the winch within those parameters.
- b. Do not step over or stand near a winch rope while under tension, the back lash from a broken cable can be fatal.
- c. Do not hook the winch rope back over itself, as this reduces the Safe Working Load by up to 50% and damages the rope. Use an approved chain, wire or synthetic band sling.
- d. Use gloves at all times when handling the cable. Frayed cable will inflict nasty wounds.
- e. Do not handle the cable closer than 750mm from the drum when winching in, particularly when wearing gloves. A loose wire may snag the glove and draw the rescuers hand into the winch.
- f. Don't winch with less than five turns of cable around the drum.
- g. Unless no other alternatives are available, do not use the winch for lifting, where personal safety is involved.
- h. Replace wire ropes which have been frayed or kinked.

5.58 The Power Take Off Winch (Mechanical Spool)

The PTO mechanical winch is operated from the power take off, attached to the gear box through a shaft, to the winch mounted on the front bumper bar of the vehicle.

The winch is driven by:

- a. Selecting neutral on the vehicle transfer case
- b. Engaging first gear in the gear box
- c. Engaging the dog clutch on the winch

- d. Connecting the winch rope to a hold fast if debogging, or to the item to be hauled.
- e. Starting the motor and operating the winch by releasing the vehicle clutch.

The winch is then in operation, winching in or out as selected, with the winch speed being controlled by the engine speed.

It is recommended that only first gear be used when winching, as higher gears permit the PTO shaft to run too quickly which can result in damage to the shaft and universal joints. An upper limit of 2000RPM is recommended in this gear.

5.59 The Power Take Off Winch (Mechanical Capstan)

This winch is mechanically the same to operate as the PTO spool winch, but differs in the 'spooling' method.

The capstan is a tapered, vertically positioned drum around which a turn or two of the winch rope (usually natural fibre), is taken. When the operator applies pressure to the running end of the rope, the turning capstan causes the rope to be recovered and thus winching occurs.

5.60 The Electrically Powered Spool Winch

The electric winch is one in which the spool or drum is driven by an electric motor, similar to a vehicle starter motor, through a gear train. The electric motor is connected by heavy duty cables directly to the vehicle battery. In most modern winches, a remote control switch to operate all winch functions is supplied and is on a lead long enough to reach back to the drivers seat. A simple 'push pull' clutch is fitted, so that the drum can free spool to permit faster run out of the winch rope by hand to the hook up point.

Although the winch will operate without the engine running, it is inadvisable to do so unless necessary, due to the load the winch imposes on the battery.

5.61 Winches, Generally

- a. Most winches have a shear pin, which is designed to shear if the winch is overloaded. The shear pin should only be replaced by a genuine replacement pin, not nails or other foreign objects, unless no other option is available. Even then, a correct pin should be inserted at the first available opportunity.

- b. When winching keep the cable straight ahead of the winch, while under load. The fairlead is designed to help with minor misalignment, but wire rope strength is severely reduced when forced to bend.
- c. Before applying a load to a new wire rope, it should be run out to the last five wraps on the drum and spooled on under a load.
- d. Always take out the slack in the rope before applying full power to the winch. Sudden jerks may exceed the rated capacity.
- e. With a PTO winch, do not release the clutch rapidly, it could shear the safety pin.
- f. Do not slip the clutch, it will overheat and it serves no purpose.
- g. Always wind the cable tightly. If it is loosely wound, the cable can be crushed and damaged when a load is supplied. A good method for winding the cable, is to extend it fully, attach it to a holdfast, and then pull the vehicle with the brakes lightly applied. Wind the entire cable with this load.
- h. Read the manufacturer's instructions and practice using the winch, before it is necessary to do so in an operation.



## CHAPTER 6

### RESCUE FROM HEIGHTS AND DEPTHS

6.0 In any major disaster, it is can be assumed that large numbers of casualties could be trapped in upper floors of buildings, in basements, or many other difficult or inaccessible areas. Some casualties may have to be helped down a ladder, while others may have to be lowered in a stretcher or slung down by a rope. In each case, the method of rescue will be dictated by the circumstances and this chapter attempts to provide some of the alternative methods of rescue, often used.

#### 6.1 IMPROVISED SINGLE POINT LOWERS (Figures 94 and 95)

The improvised methods shown in this section would normally only be used when, because of fire or other emergency combined with a lack of equipment, immediate evacuation of the casualty is imperative.

The techniques are normally used with a chair knot or if available a stretcher and consists of taking two round turns around an anchor point as a belay. Gloves must be worn in case the rope slides through the hands of the rescue member, but the rope should be paid out 'hand over hand'. A more satisfactory single point lower technique, can be achieved with a figure eight descender (Para 6.11 refers).

The method shown at figure 96 can be used as a quick method of descent, by using the ladder as a breaking device, however the rope should be kept as close to the end of the rungs as possible, and the structure must be sufficiently strong to support the load imposed by the head of the ladder.

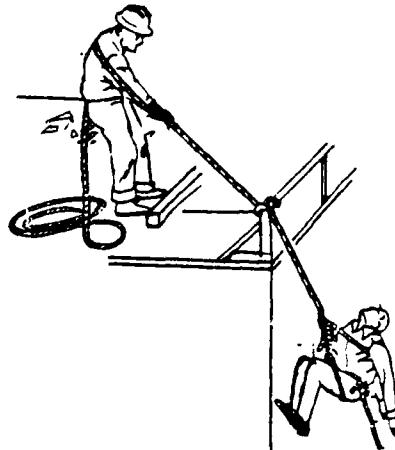


Fig 94.

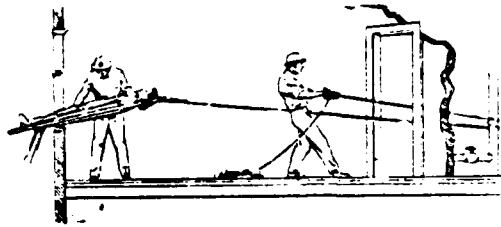


Fig 95.

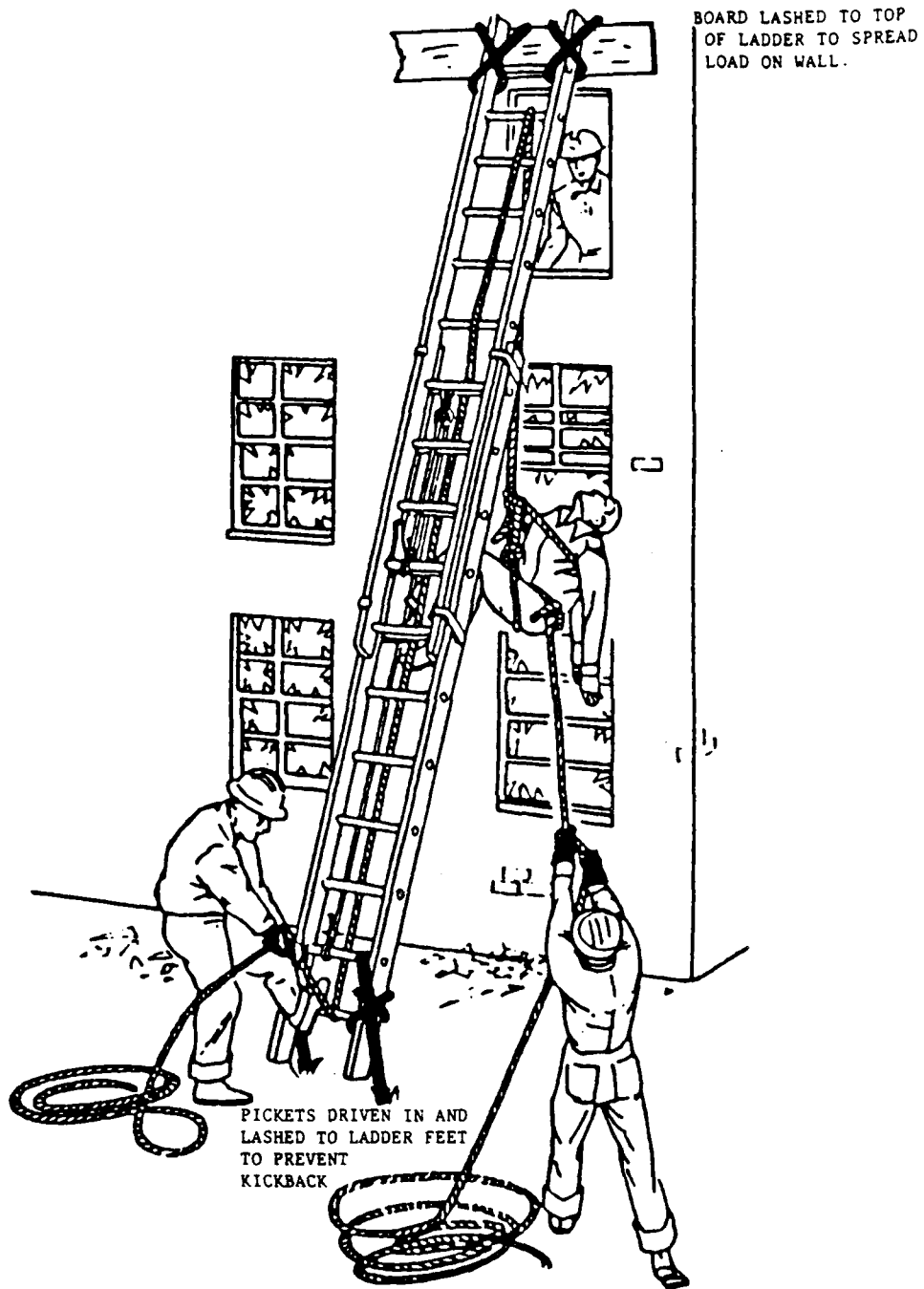


Fig 96.

6.2 STRETCHERS IN RESCUE

This section deals with many rescue applications using stretchers and while the stretcher used to demonstrate these techniques is the Pole Stretcher or MK2, it should be understood that all the techniques, can also be successfully carried out with other types of stretchers.

6.3 TWO POINT VERTICAL SUSPENSION (Figure 97)

Of the various methods of getting a stretcher down from a height, this one is undoubtedly the simplest.

The casualty is blanketed and lashed to a stretcher in the normal way, with the addition of a bandage tied across the forehead to prevent the head flopping forward, if the casualty is unconscious. If the casualty has only to come down one storey, a 12m/16mm lashing is middled and the ends tied with a bowline to the top two stretcher Ds.

The same procedure is used for the foot of the stretcher and the lashing passed out to the two rescuers on the ground. The two rescuers above, then ease the stretcher over the edge of the wall, handling it by the strings, until such time as they come to the guide lines with which they lower away hand-over-hand. The two rescuers on the ground, steer the stretcher clear of any obstruction and walking in on the guide lines, support the stretcher on either side as it comes down. This technique can be used equally well inside the building, using a hold found or cut in the floor. If possible, do not cut through floor joists as it takes longer and weakens the whole structure. Four rescuers is the ideal team for the job, although two rescuers can do it if there is adequate landing space for the stretcher on the floor below.

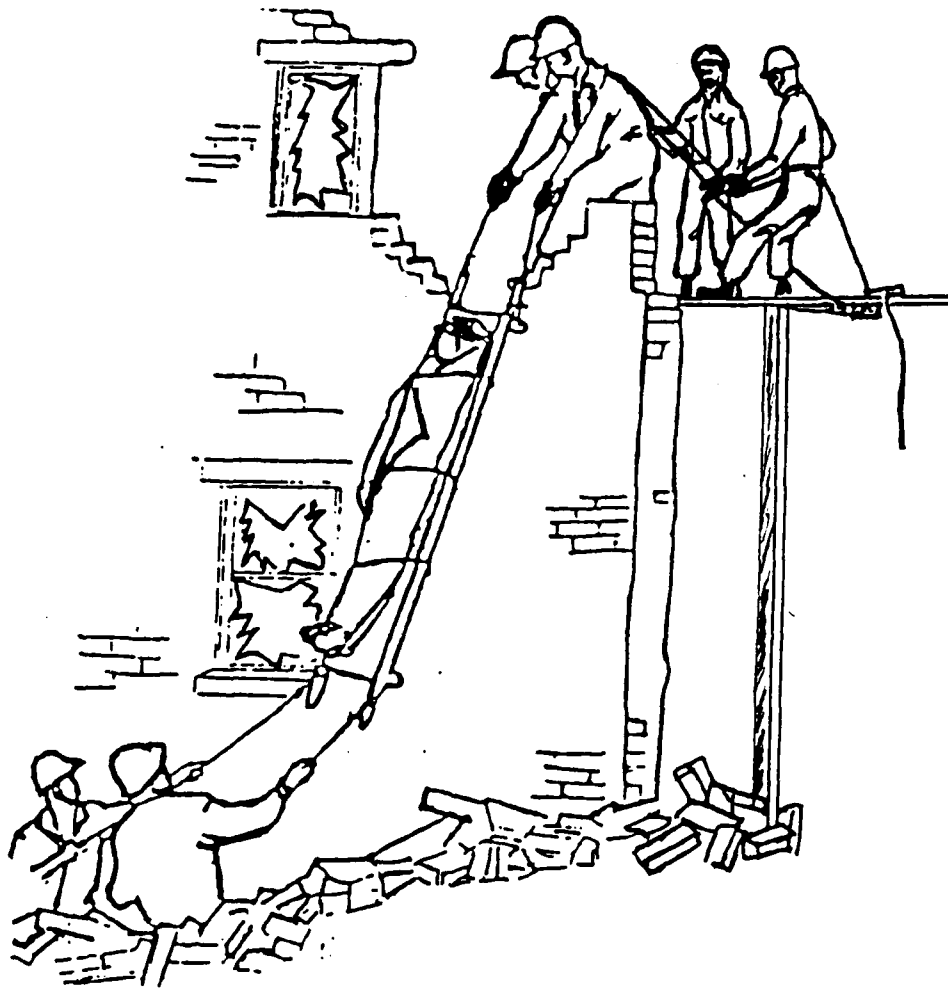


Fig 97.

6.4 FOUR-POINT HORIZONTAL SUSPENSION (Figure 98)

Where it is essential for medical reasons to keep the casualty horizontal, the four-point horizontal suspension can be used.

The stretcher is rigged in the same way as for the two-point suspension, except that it is advisable to use four separate lashings - one for each D on the stretcher. A suitable hole must be found or cut in the floor (about 2.3m x 750 mm) as required, and the stretcher is then manned and lowered as shown in Figure 98.

The rescuers on the far side pull the stretcher across until it is located over the centre of the hole. Manpower requirement above, is four, unless the casualty is very light, in which case two rescuers positioned at the head and foot of the stretcher can do the job - each manning two ropes. If no suitable landing is available for the stretcher below, two rescuers will be required there.



Fig 98.

6.5 LADDER HINGE (Figure 99)

This is a comparatively simple and quick method of getting a casualty down from an upper floor, when it is desirable to keep the stretcher horizontal, or the building is so unstable that it cannot be used to assist in the operation.

The casualty is blanketed and lashed to a stretcher in the normal way with the ladder placed vertically against the wall in front of the opening where the stretcher is to come out. No 2 supports the head of the stretcher, while No 3 lashes the foot of the

ladder, about 25 cm above the window opening (Figure 99(a)). The lashing is applied with a 12mm x 3m lashing as follows. Start with a bowline tied through the D on one side of the stretcher. Next a half hitch is taken around the ladder string and the side of the stretcher, drawn until it is about 25cm clear of the sill. Six to eight round turns are taken around the rung, half hitched to the string on the opposite side of the ladder and finally secured to the other D on the foot of the stretcher, using a round turn and two half hitches. This hitch is used so that the stretcher may be adjusted for lateral balance. Two 12m/16mm lashings are then tied to the top stretcher Ds, (bowlines) for use as guidelines. When all is secure, the word is passed to the leader and he gives the order 'lower away gently', and the stretcher is passed out the window by Nos 4 and 5, who eventually support the head end of the stretcher by the lowering lines (Figure 99(b)). Nos 2 and 3 remain close to where the ladder has been footed, and ensure no side sway develops, while the leader walks backwards, hand over handing each rung and controlling the speed of the whole operation. The stretcher should finally come to rest on top of the ladder flat on the ground, where No 2 and 3 can quickly disconnect the hinge and remove the casualty to safety.

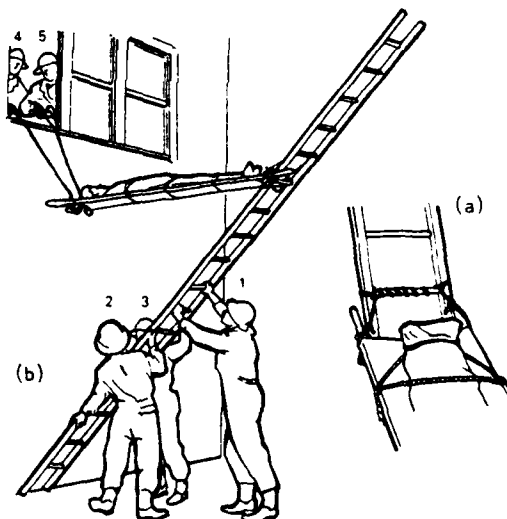


Fig 99.

6.6 LADDER SLIDE (Figure 100)

This is an extremely sound method of getting a casualty up or down from the first or second floor.

The casualty is blanketed and lashed to a stretcher, with two lowering lines secured to the top Ds with bowlines. The ladder is placed in position by the three rescuers on the ground, with one rescuer (No 4) footing it and one rescuer (No 5) acting as a human prop. The leader, (No 1), climbs the ladder, taking with him two pick handles or equivalent sized pieces of wood - one of which he passes into the building. The foot of the stretcher is passed out on to the ladder and No 1 places a pick handle through the two bottom stretcher Ds. The stretcher is then moved down the ladder until such time as the head end passes clear of the opening. Nos 2 and 3 place the second pick handle through the top stretcher Ds and secure it by taking a round turn around the pick handle and a half hitch about the handle of the stretcher on each side (Figure 100(a)). The stretcher is slid down the ladder, Nos 4 and 5 assisting with its carriage when No 1 is on the ground. (Fig 100b).

The rescue can be undertaken with only 4 rescuers by securing the foot of the ladder as in Fig 100(c); and in this case, No 5 would assist No 1 with the stretcher, when the stretcher weight was removed from the centre of the ladder.

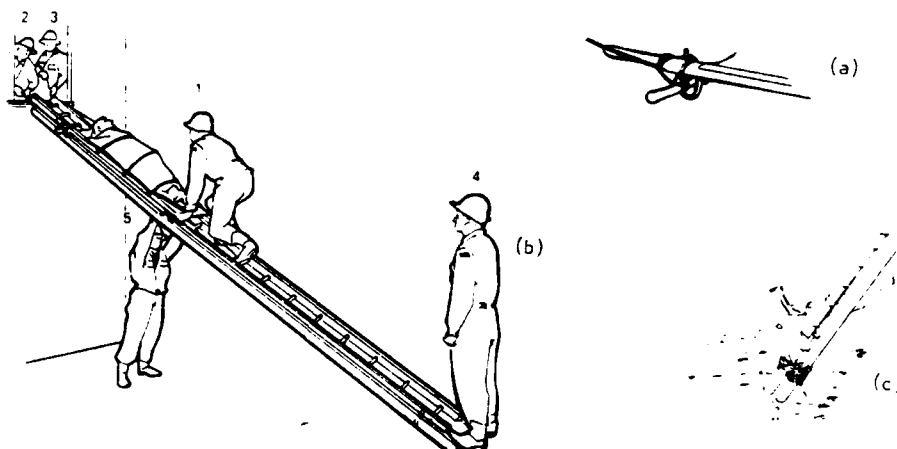


Fig 100.



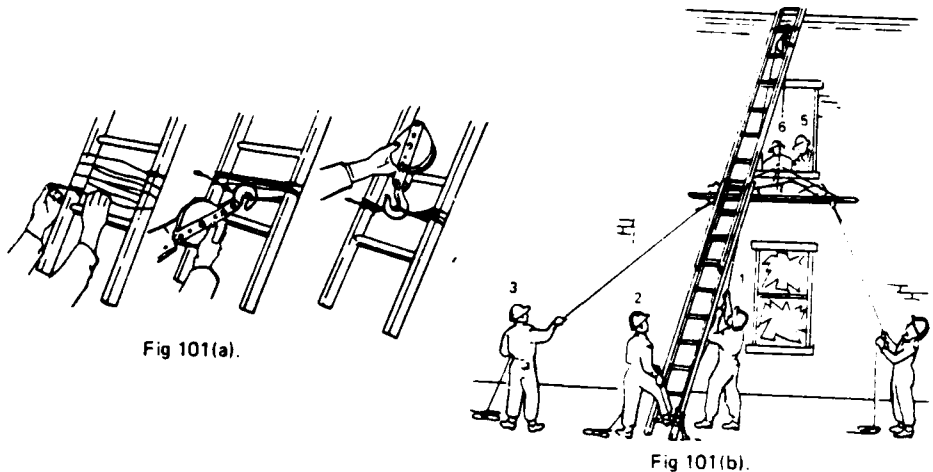
6.7 LEANING LADDER (Figure 101)

This is a technique for getting casualties down from upper floors of a building, in the horizontal position. Where the structure has been carefully inspected and is considered suitably strong to support the load imposed at the head of the ladder.

A snatch block is attached to the head of the ladder using a wire bond, as illustrated in Figure 101(a). Start by passing the bond through its own eye and finish up on the opposite side of the ladder with a clove hitch. Insert the hook of the block on the lower turns and tip it over, producing the figure of eight effect shown. Do not make the bond turn too tight or it will be found that the block cannot be tipped over.

A 16 or 24mm lowering rope is then reeved through the block and temporarily tied to the bottom of the ladder. The ladder is raised to the vertical and extended until the snatch block is at least 3m higher, than the bottom of the opening from which the casualty is to come out. The rescuers up top (nos 5 and 6), should by this time have the casualty blanketed and lashed to a stretcher with two guide lines secured to the outside stretcher Ds. These lines are thrown down to the rescuers on the ground (Nos 3 and 4), before the lowering operation starts. A chair knot is fitted to the stretcher and the lowering rope attached to it by means of a round turn and two half hitches. No 2 takes the other end of the lowering rope under the bottom run of the ladder and stands braced ready to haul in, or lower away as directed by the leader. The leader places himself under the ladder and assists No 2 with the lowering ropes and gives the appropriate orders, as and when required. It will be noted that should the leader have, for any reason, to leave his position he can do so with the assurance that No 2 will be able to support the weight of the stretcher.

If a narrow window opening is being used, initially the stretcher will have to be lifted by Nos 5 and 6 and pushed out at an angle between the window and the ladder, then turned parallel to the wall by Nos 3 and 4, on the guide lines. The operation is completed by the leader and No 2 carefully lowering the stretcher to the ground.



#### 6.8 THE LADDER DERRICK (Figure 102)

This technique has particular application, where the structure from which the casualty has to be removed, is so unstable that it cannot be used in any way to assist the operation. In this case the rig is self-supporting and does not depend on support from the building in any way. The first step in erecting the ladder derrick, is to rig the head of the ladder as in figure 102(a). The snatch block is attached as for the leaning ladder; then the 24mm rope secured between the top two rounds and tied back on its standing part with a bowline. This is used as a back tied guy and carries the main load. Next, a 16mm rope is middled and clove hitched to the top of the ladder strings, and the ends are crossed to form the side guys. It is often a good plan, to attach another rope to the centre of the top round to act as a front guy. This greatly assists in erecting the ladder, when the time comes. The 16m rope is reeved through the snatch block and is used for lowering the stretcher.

Three sets of picket holdfasts are then driven to support the back and side guys. In good holding ground, one to one is usually sufficient for the back guy and single pickets for the two side guys. If possible, the side guys should be located in front of the point, where the ladder is to be footed. Holdfasts should always be at least double the height of the ladder, out from its foot.

The ladder is now ready to be erected and under the control of the leader - Nos 3 and 4 under run the ladder while No 2 foots it. All guys should be manned and if a front guy is attached, Nos 8 and 9 can assist in getting the ladder into the vertical position. Once

there, it is extended to the required height and, after being squared up by the leader, the guys made fast with a round turn and two half hitches. Remember the guys stretch when under load and may have to be adjusted from time to time.

If necessary, the foot of the ladder should be dug in or picketed. From here onwards, the operation is the same as for the leaning ladder method, with the exception of the personnel numbering in the two figures. At all times while the rig is under load, the holdfasts should be carefully watched to ensure they show no signs of pulling out. Nine is the ideal number of rescuers required for the ladder derrick, although seven can be used if the two side guys are left unmanned. If this is the case, No 7 (the back guy man), should be detailed to watch the three sets of holdfasts.

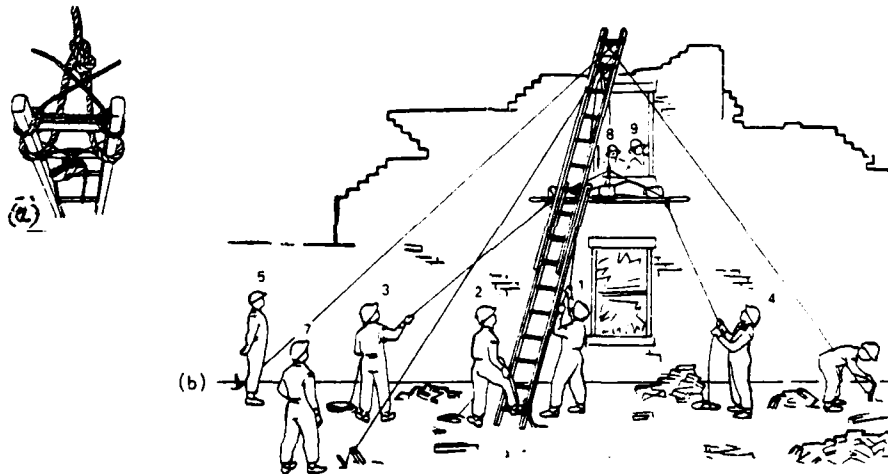


Fig 102.

#### 6.9

#### MECHANICAL DESCENTS

There are numerous mechanical devices available which assist in lowering casualties from heights, many are complex and expensive, but two devices are both simple and inexpensive. These devices are the KARABINER (Fig 103) and the Figure of Eight Descender (Fig 104). Both devices when used for descent work, use a simple friction principle, to inhibit the run of the rope; which must be 11mm to 14mm kernmantel synthetic fibre rope, or in an emergency a 12mm Manila rope. Should a laid rope be used, it should be noted that the technique is very severe on the rope and the descender, and that the figure 8 descender will impart considerable spin to a laid rope. A careful inspection should be made following each operation. All ropes must be regularly checked for signs of wear.

6.10 THE KARABINER (Figure 103)

This device is a metal snap link used for joining two ropes, harnesses or devices together. It has a gate on one side, which can be opened inwards to allow the rope to be inserted. The gate is spring loaded and is prevented from accidentally opening by a screw lock keeper. Good quality karabiners should have a rated breaking load of 2500kg or better on the major axis (the spine), and may also be rated at 600kg, or better across the minor axis. A number of climbing karabiners on the market, do not meet these specifications and should be avoided. The karabiner can be used as a descent device in its own right, but this is highly dangerous, and it should always be used for this purpose in conjunction with a figure 8 descender or other friction device. Karabiners are manufactured in both steel and high tensile alloys, with and without safety screw locks on the gates. Rescue karabiners should all be steel screw lock models. The devices must never be thrown, dropped or subjected to hard impacts. A moderately hard impact can cause severe damage which is invisible to normal inspection procedures.

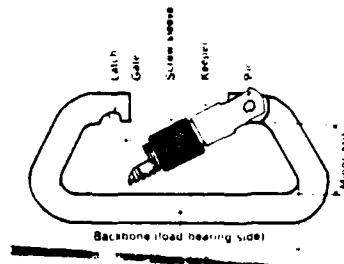


Fig 103.

6.11 THE FIGURE EIGHT DESCENDER (Figure 104)

This device is constructed of high tensile alloy or steel. Some manufacturers produce descenders coated with a hard wearing finish, to resist wear and assist with heat dissipation.

The device is simple, has great strength and versatility and should always be used in conjunction with a Karabiner. Care should be taken with the figure eight descender to ensure that it is not dropped, or subjected to hard impacts as this may cause invisible fractures in the metal.

The commonly available climbers figure 8 descenders have rated breaking strains between 1600 and 2250kg, while the larger descenders and the newer steel figure 8 devices, have BS between 2000kg and 5000kg.

Ropes worked through a figure 8 descender under tension, must be let out slowly to avoid the build up of friction heat, and possible rope damage or melt through.

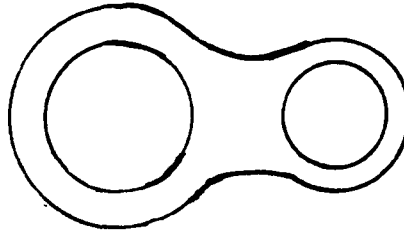


Fig 104.

6.12 THE BASIC HOOK UP (Figure 105)

- a. Take a bight in the rope and pass it through the upper (larger) oval ring (Figure 105(a)).
- b. Pull the bight down below the lower (smaller) ring (Figure 105(b)).
- c. Pull the lower ring through the bight with slight tension on the rope (Figure 105(c)).
- d. Attach the Karabiner to the lower ring for connection to the stretcher bridle or harness as required. (Figure 105(d)).

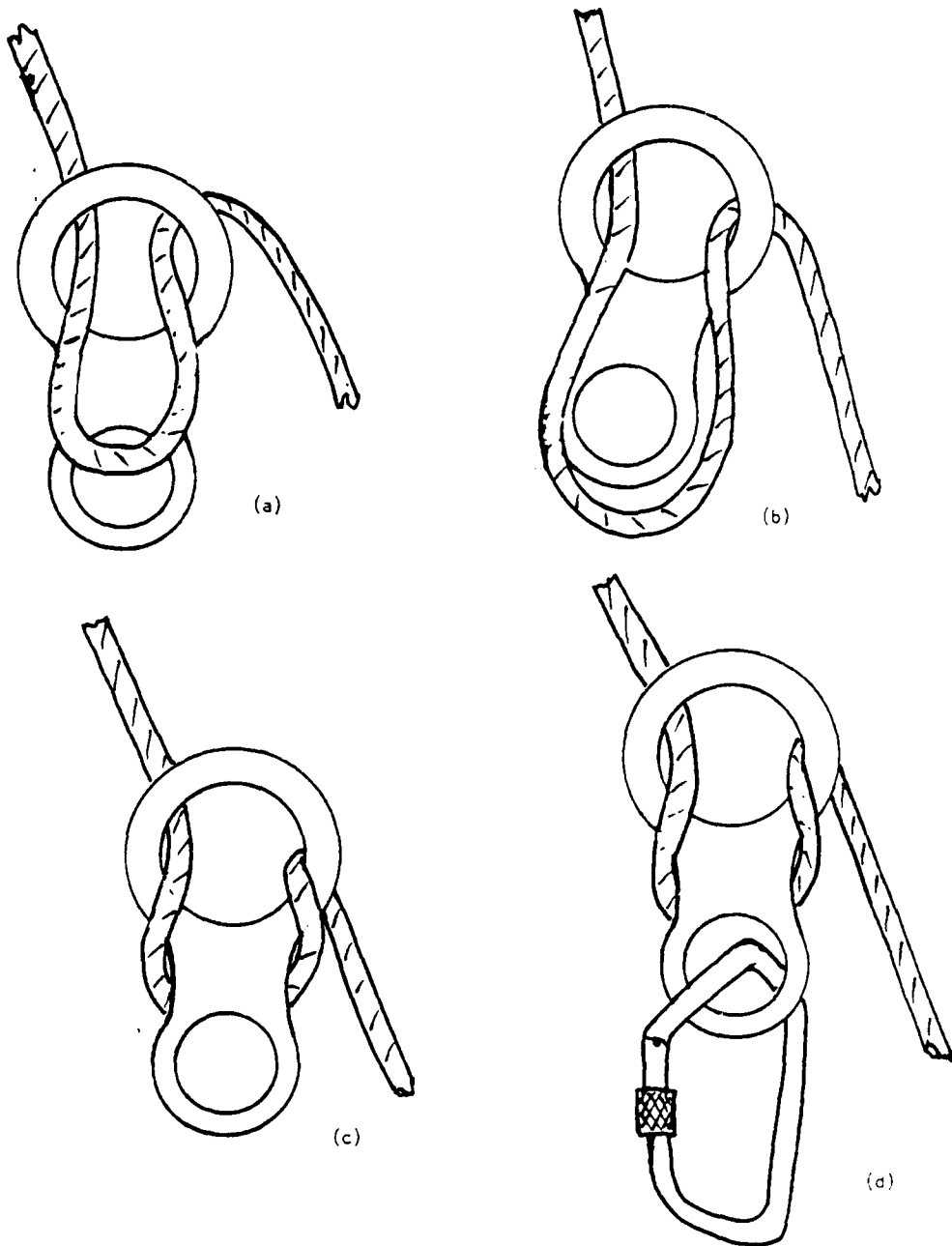


Fig 105.

6.13

SAFETY POINTS

- a. Make sure the keeper on the karabiner gate is screwed home - finger tight only.
- b. Do not permit cross loading of the karabiner, particularly across the gate
- c. Treat karabiners and figure eight descenders carefully. Dropping may cause hairline fractures.
- d. Avoid cutting, filing or stamping. Use paint for identification only.
- e. Keep the gate lock mechanism clean and lightly oiled.
- f. Keep all descents to less than 15 metres per minute, to prevent excessive heat build up in the device which could damage the rope.
- g. Refrain from hard breaking of a descent - this only places undue loading on the rope and holdfast.

6.14

HORIZONTAL DESCENT - CONTROLLED FROM BELOW  
(Figure 106)

The descent rope should be tied off to a substantial hold fast by a Fishermans Bend or an equally substantial method; strap or tie the casualty onto the stretcher and connect a four point bridle or chair knot to the stretcher. Check the bridle and stretcher for balance.

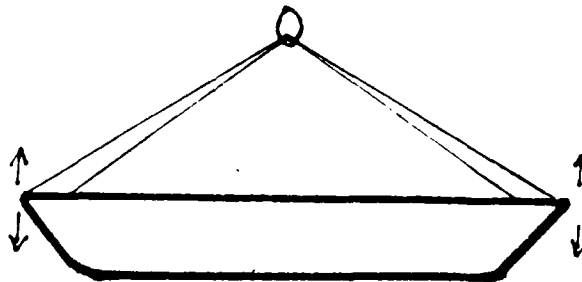


Fig 106

Hook up the figure eight descender, as in Para 6.12 to the descent rope and connect the karabiner to the four point bridle or chair knot. (Figure 107)

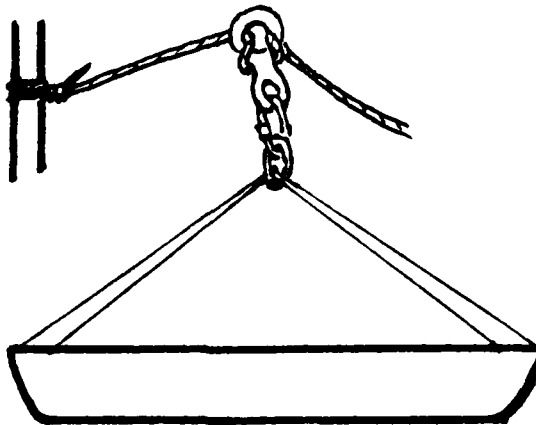


Fig 107.

Throw the free end and coiled rope to the ground. One team member must hold this rope with sufficient tension, to prevent the figure eight from running down the rope.

Ease the stretcher out, until it is suspended fully by the rope. The member controlling the tension should gently release the tension on the rope, until the figure eight descender and stretcher start to descend. By 'feeling' the tension on the rope, a smooth descent can be made with little physical effort involved. (Figure 108)

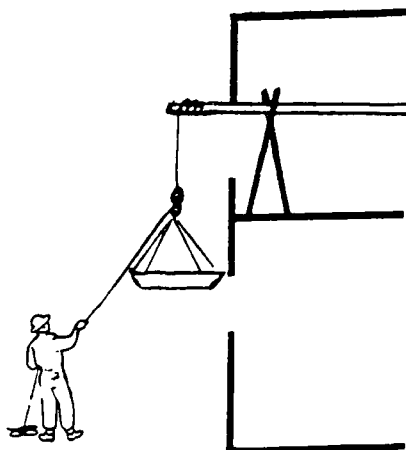


Fig 108.

Depending on the descent, two guide lines may be required to clear the wall.



6.15 THE VERTICAL DESCENT - CONTROLLED FROM BELOW  
(Figure 109)

Using the standard figure eight hook up, attach the Karabiner to a two point bridle connected to the top of the stretcher.

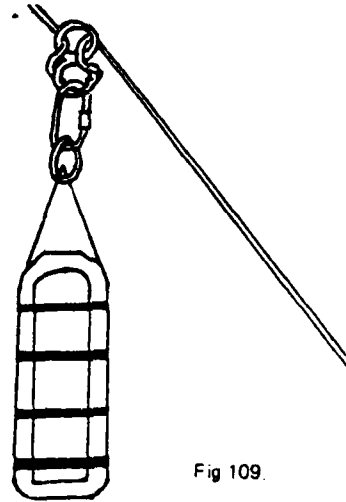


Fig 109.

Connect two light guide lines to the foot of the stretcher to assist in keeping the stretcher out from the wall. The descent technique is as for the horizontal descent controlled from below. Ensure that the casualty's head is restrained from falling forward by tying a restraining cloth across the forehead. The above techniques can be used as effectively with casualties in chair knots or specialized rescue harnesses.

6.16 DESCENTS - CONTROLLED FROM ABOVE (Figure 110)

The technique involved with controlling a mechanical descent from above, is similar to that for controlling from below, except, in this case the figure eight descender remains stationary and the rope runs through the device. For this reason, in controlling from above, it is obligatory for the member controlling the

descent to wear substantial gloves. Hook up one end of the rope to the figure eight descender in the normal way and connect the karabiner to the smaller ring. Connect the karabiner to a substantial hold fast by means of a 12mm lashing or other satisfactory method.

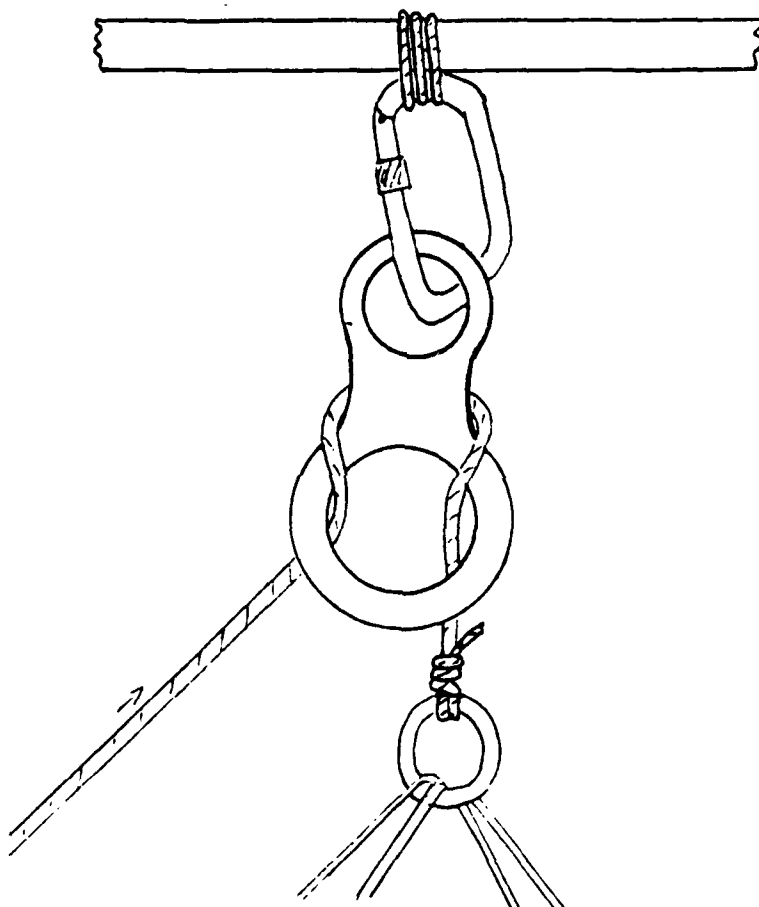


Fig 110.

Connect the shorter free end of the rope to the bridle of the stretcher with a figure of eight loop or fishermans bend. Connect guide lines to the foot of the stretcher if required. Holding the free end of the rope firmly about 1 metre from the descender and ensuring that the rope coil is not impeded in any way, ease the stretcher out over the descent and permit it

to lower by controlling the tension on the rope as it feeds through the figure eight descender. An around the waist or over the shoulder additional belay can be used in conjunction with this method. Maximum controlling or breaking effect is achieved when the rescuer pulls the control rope back towards the descender anchor point, in line with the body of the descender. This technique can be used for horizontal, vertical or individual descents in harnesses.

6.17

#### Climbing Tape

Climbing tape or webbing is commonly made from Polyamide (Nylon) in widths of 25mm and 50mm. With rated material breaking strains between 1250 kg and 3000 kg, tape is ideal for all manner of anchorage and attachment purposes, and is in normal use with karabiners and figure eight descenders.

Tape is normally tied off into slings with circumferences of 1200mm and 2500mm, referred to as 'single' and 'double' tape slings. Slings can be tied off to any length for particular purposes.

The ONLY safe knot for joining tape is the Tape Knot or Overhand Bend (Figure 111).

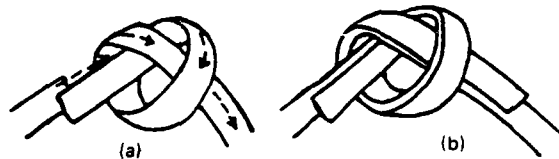


Fig 111.

When tied off to form a sling with the Tape Knot, the sling has a theoretical breaking strain double that of the tape material. In practise, it is customary to observe a breaking strain rating which is 2/3 of the doubled material BS, and 1500 kg tape in sling format is given a rating of 2000 kg.

For anchorage purposes, a tape sling should be passed completely around the anchor point, and attachment made with a screwgate karabiner to both ends of the sling (Figure 112). The Larks Head Hitch (Figure 113) dangerously weakens the material, and is not safe for rescue.

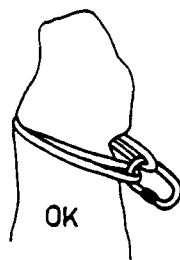


Fig 112.

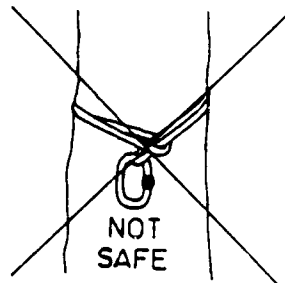


Fig 113.

Some examples of the uses of tape slings in general rescue are:

Suspension of blocks from derricks.

The 'hinge' in a ladder hinge.

Anchorage of a figure eight descender.

Tape must be treated in the same manner as synthetic rope, and subjected to all normal inspection and safety procedures.

#### 6.18 THE JIB (Figures 114 and 115)

Basically, the jib consists of a pole projecting about one metre (horizontal distance) over the side of a building, with a snatch block attached to the end, through which is reeved a lowering rope. It is a quick method of lowering stretchers in a horizontal position. The timber used for the jib must be strong enough to allow the one metre projection to bear all weight. A couple of rafters bound together should be quite adequate.

Before pushing the jib pole out, the snatch block must be secured. To do this, middle a 12mm lashing and clove hitch the middle of the lashing to the hook of the block. Then cross the two running ends over the top of the pole about 30 centimetres back from the end. Take two or three cross-over turns over the pole and through the hook, then frap the centre of the lashing again using the cross-over turns and finish off with a reef knot. Reeve off the lowering rope and tie a thumb knot 2 m or 2.5 m back from the running end to prevent it running back through the block.

Alternatively, a Nylon tape sling can be passed several times around the pole about 300mm from its end. The block should be secured to both ends of the sling with a screwgate karabiner, and the hook securely moused.

NOTE: Ensure that the lowering rope is reeved through the block, so that the running end goes directly from the block to the lowering party, and the standing part is led to the casualty by the same way the casualty will leave the structure.

The pole must then be firmly lashed in position, making sure that the snatch block is in the centre of the opening and about 1m out from the wall. It is important that the pole be lashed as near to the point where it passes over the wall as possible, as side strains will often be set up during the lowering operation. The other end of the pole must be also lashed down to a solid part of the building. Remember this end of the pole will tend to lift - this point must be borne in mind when selecting an anchorage. It is not necessary that the pole should be at right angles to the wall or that it should be in the horizontal plane, eg, the inside end of the pole could be tailed down to a floor joist if it were solid. The casualty is blanketed and lashed in the usual way and a chair knot applied or four point bridle connected. Two guide lines are bowlined to the outside stretcher D rings or handles and thrown down to the rescuers on the ground. The lifting rope is secured to the chair knot or D ring with a round turn and two half hitches.

At least two, preferably three, rescuers will be required on the lowering rope under the control of the leader. When all is ready the weight is taken on the lowering rope and the two rescuers up top ease the casualty out through the opening, feet first. As soon as possible the rescuers on the guide lines swing the stretcher around parallel to the wall and lowering commences. If necessary, the guide line rescuers can pull the stretcher out to a clear landing space as it comes down. They should walk in on their lines so as to be ready to grab the stretcher when it comes in reach.

The jib can also be used successfully as a secure tie off point for descents using figure eight descenders, by leaving off the snatch block and tying the rope directly to the padded end of the jib.

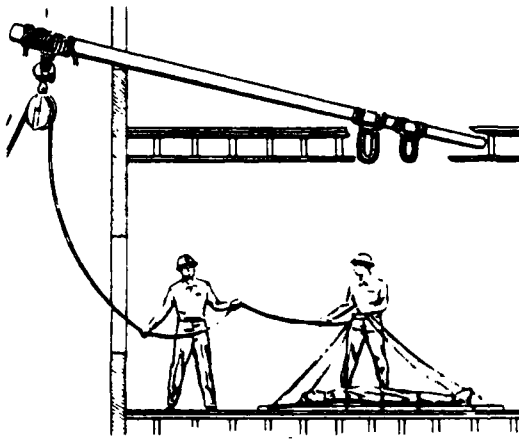


Fig 114

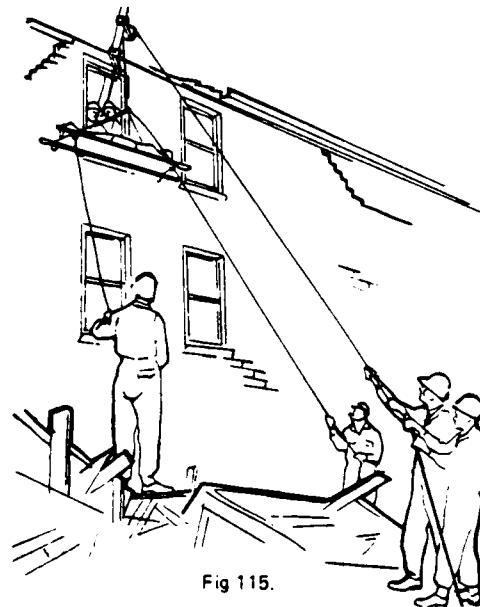


Fig 115.

6.19 FLYING FOX (Figures 116, 117 and 118)

This is a relatively simple method of getting casualties down from heights and across obstructions, in the horizontal position using a 24mm rope. The tie off points however, (eg, building, tree, etc) must be capable of standing the additional strain placed upon them.

6.20 SAFETY

- a. The flying fox rope should NEVER be over tensioned with a Tirfor winch, but preferably be tensioned by having 4 to 6 rescuers hauling on it.
- b. The sag in the rope should never be LESS than 5% of the length of the span. The greater the sag the less tension on the rope.
- c. The following is a formula for calculating the tension on the rope.

$$\text{Tension on Rope} = \frac{W \times L}{4 \times S}$$

Where W = Load in kg

L = Length of span in metres

S = Sag in metres

Assume a flying fox as in Figure 98 with a stretcher load of 100 kg (W), a span length of 80 metres (L) and a sag of 5 metres (S).

$$\text{It can be seen that } \frac{100 \times 80}{4 \times 5}$$

= 400 kg tension on the flying fox rope for a stretcher load of 100 kg.

Should the sag be reduced by tensioning the rope with a mechanical device such as a tirlor so that only 2 metres of sag remain, then:

the load (W) is 100 kg, the span (L) 80 metres and the sag(S) is 2 metres.

$$= \frac{100 (W) \times 80 (L)}{4 \times 2 (S)}$$

TENSION in the rope = 1000 kg for a stretcher weight of 100 kg. The safe working load of a 24mm rope is 576 kg without deductions for knots etc. This practice then becomes UNSAFE.

It is re-emphasised that the sag in a Flying Fox rope should never be less than 5% of the length of the span and that 24mm manila or sisal is the minimum rope size for the main span of a flying fox.

#### 6.21 CONSTRUCTION (Figures 116 and 117)

The rope on which the snatch block runs (24mm), is first secured to a strong tie off point well inside and above the point from which the casualty is to be lowered. This permits clearance of the stretcher from the floor or ground once it is connected to the snatch block. In some cases it may be necessary to construct A frames to gain clearance or use the fork of a tree.

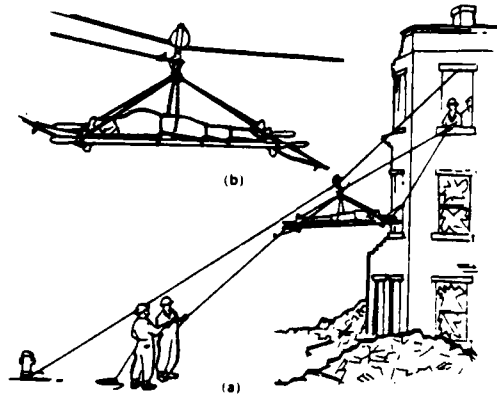


Fig 116.

The other end of the rope is secured to a holdfast on the ground and once again it may be necessary to use an A frame to assist with clearance. Before the rope is made off, it should be tightened by four to six rescuers hauling on it or by tying off and tensioning by pushing an A frame into position.

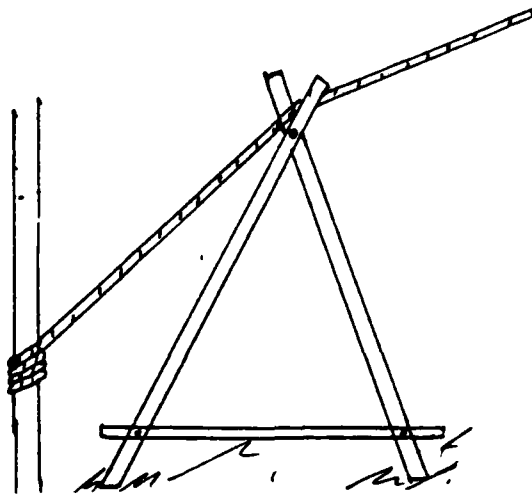


Fig 117.



Secure the rope with two round turns and two half hitches. The stretcher is blanketed and lashed in the normal way and the chair knot or four point bridle fitted and tested for balance.

16mm guide/safety ropes are attached to the travelling block and led to each end of the fox span. Each of these ropes must be slightly longer than the entire span.

Although these ropes are principally for lowering and guiding purposes, it should be remembered that they serve a dual role in that they must support the stretcher should the main rope, an 'A' frame, or an anchor point fail. These ropes should be paid out and taken in under tension through round turns and taken around anchor points by rescuers wearing gloves.

When all is in readiness, the hook of the snatch block is slipped under the middle rope of the chair knot (FIG 118) or the 'D' ring of the four point bridle and the hook moused.

The line on the foot of the stretcher is thrown down to the rescuers on the ground. The stretcher lifted by the rescuers up top, the snatch block slipped over the 24mm rope and the gate secured with the pin.

The casualty is then lowered carefully by paying out and taking in on the guide lines. This must always be done by hand over hand method - never let the rope run through the hands.

If more than one casualty has to be transported across or down, the chair knot can be attached to another stretcher on which is placed blankets etc, and the lot hauled up with the line made fast to the snatch block.

In this respect, the flying fox is a good method of moving stretcher casualties trapped in the upper floors of buildings.

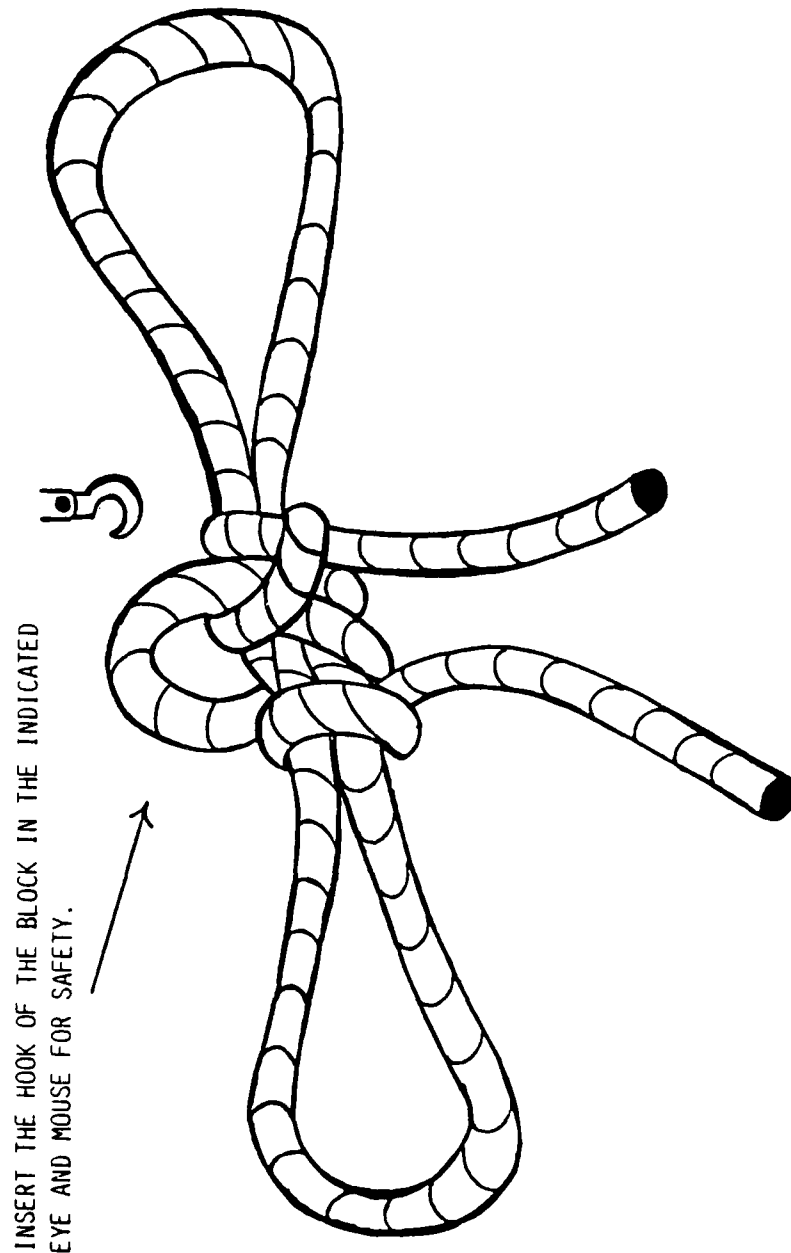


Fig 118.

## CHAPTER 7

### DAMAGE TO BUILDINGS, DEBRIS CLEARANCE AND TUNNELLING

#### DAMAGE TO BUILDINGS

- 7.0 The type of construction of a building gives some indication of how it may collapse, as a result of a blast or cyclonic wind. Almost all types of structures will contain voids or spaces in which trapped persons could remain alive for relatively long periods. To know where these safe places may be, it is necessary to know the broad characteristics of construction types.
- 7.1 Types of Buildings
- Buildings can be grouped into categories by the methods and materials used in their construction. The main categories are as follows:
- a. unframed buildings
  - b. partially framed buildings
  - c. fully framed buildings
  - d. monolithic buildings.
- 7.2 Unframed Buildings (Load-bearing Walls)
- The term unframed means that there is no skeleton of steel or reinforced concrete taking the load.
- 7.3 Partially Framed Buildings
- Partially framed buildings characterise those which are halfway between framed and unframed ie, buildings containing a share of each. The external walls form the unframed section as they are load-bearing, and the framed section comprises the posts and beams erected to replace the load-bearing internal portions. Partially framed buildings of an old-fashioned type usually incorporate timber posts and beams, providing support for timber floors, or cast iron columns moulded for strength and appearance, and beams of iron and timber or inverted tee section cast iron. In the more recent buildings of this type, however, the columns and beams are constructed of steel and are similar to those used in modern fully framed buildings.

#### 7.4 Fully Framed Buildings

Fully framed buildings are so described because they have a skeleton frame which carries all the loads, including the weight of the walls. The frame may consist of steel, reinforced concrete or timber. Foundations are usually formed individually for each stanchion, and may consist of comparatively small blocks of solid concrete, large reinforced concrete or steel joists encased in concrete. Where steel is employed, steel joists are laid side by side, each layer running at right angles to the one beneath and bolted together. This type of foundation is known as a grillage, to which the base plate of the stanchion is bolted. When the stanchions have been fixed the whole floor area is excavated and covered with solid concrete with or without steel reinforcing. The frame is formed by fixing the stanchions to their concrete bases, and fixing between them at suitable levels, steel beams which will support the floors and transmit the load to the stanchions. These stanchions or beams may be encased in concrete or brickwork to protect the steel in case of fire. When the frame is of reinforced concrete, steel rods will be incorporated in the concrete in place of steel stanchions and beams. With a timber-framed building the foundations can be either concrete, stone, brick or timber. The external and internal linings are fastened to the loadbearing timber frame. The roof, which can be either gabled, flat or skillion, usually consists of tiles, corrugated iron or fibrous cement roofing.

#### 7.5 Monolithic Buildings

Monolithic buildings, as the name implies, are built in one piece starting from the foundations and these (the frames, walls and floors, staircases and roof) are formed of reinforced concrete on the site, as they occur in the building, as it rises. The mass of reinforcing rods is carefully set out as each bar is hooked and wired in position, to form the raft or base of the building and partly up the walls and piers or columns. The timber formwork for the walls is then fixed in position, the steel reinforcement placed and the concrete poured over and worked around the bars. When the concrete is set the form-work is removed and the next stage proceeds, and so on upwards to the top of the roof, the floors being placed as the walls rise. The roof is constructed in the same manner as the rest of the building, and when the building is completed all the various elements are intimately linked together. Depending on the type of construction almost all damaged buildings will contain voids or spaces in which trapped persons may remain alive for comparatively long periods. From a rescue point of view the cause of the danger is immaterial, but it is of vital importance that collapsed floor positions be studied and their value in relation to the extrication of casualties be appreciated.

TYPES OF COLLAPSE (Figures 119, 120 and 121)

7.6 In the following paragraphs there are descriptions of various types of collapse. Each will vary according to the degree of damage; however, in the interest of safety to both the trapped and the rescuers, a thorough appreciation must be made before any rescue operation is commenced. Some of the main considerations are:

- a. Do not move any debris in contact with the collapse without assessing its value.
- b. Provide tension struts between good walls and the leading edge of floors in the case of lean-to and braces between the two floor edges in the case of a "V" collapse.
- c. Always construct a dead shore before entering a void caused by horizontal collapse.
- d. Always appreciate the forces and their possible direction of movement in all types of collapse.
- e. Pack and support vertically, horizontally and laterally whenever and wherever possible.
- f. In all materials used, consider their strength in relation to the loads to which they will be subjected.

All buildings when subjected to sufficient pressure will collapse in a manner which is largely dependent upon the type of construction, but in most instances the floors, ceilings and roof will collapse in large sections and not disintegrate into a large number of small segments. Cyclonic pressures on roofs is the exception to this rule. These large sections when they fall must create voids, the most common of which are:

- a. the "V" type
- b. the horizontal
- c. the lean-to.

7.7 The "V" Type Collapse (Fig 119). This can occur in any type of building, but is more general in the unframed type and is caused by a heavy weight of debris such as roofing, ceiling, furniture, etc., falling on or near the centre of an upper floor or ceiling causing the joists to break and collapse in the form of a "V", thus creating two voids in which casualties may be trapped.

7.8 The 'lean-to' Collapse (Fig 120). In many cases only one of the two load-bearing walls will collapse, and in this instance the upper floor ceiling will 'hinge' on the remaining wall, thus creating the most common and

the most difficult type of collapse with which to deal. Precautions must be taken at the earliest possible moment to prevent a complete collapse by tommying up or strutting.

- 7.9 The 'horizontal' Collapse (Fig 121). In some cases both load-bearing walls may be sufficiently damaged to permit the upper floor or floors, ceiling or roof to pancake down into the room below. This debris must inevitably land on furniture or some other obstruction, thus creating a void. Reinforcing rods and fire-distorted structural steel may create difficult and hazardous rescue problems. However, these materials will create many safe places from which people may be rescued. Rescue from framed structures may not be as difficult as from unframed, except for the fact that these buildings are usually large and multi-storied.

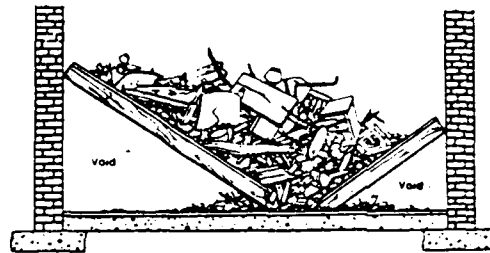


Fig 119.

'V' type

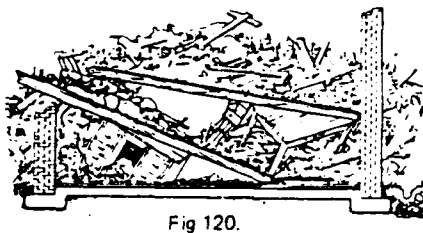


Fig 120.

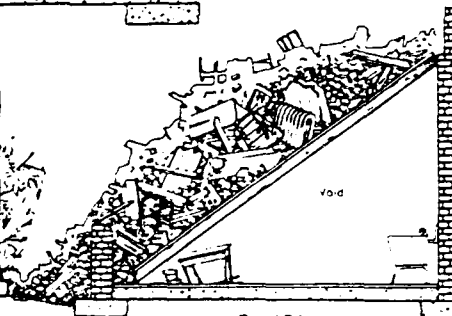


Fig 121.

#### HAZARDS FROM DAMAGED UTILITIES

- 7.10 Any disaster will invariably result in ruptured electrical, water, gas and sewer lines and, although these will be primarily the responsibility of the Public Utility, it is essential that Rescue Personnel be trained to deal with this problem in the initial stages.

7.11 Domestic Gas

Escaping gas in basements and confined areas creates danger of explosion and the following safety precautions must be observed:

- a. Never look for a suspected gas leak with a match or other open flame.
- b. Never attempt to ignite a gas leak. This is a job for an expert.
- c. Never smoke in a confined space where gas may be present or is suspected.
- d. Never use power tools or oxy-acetylene torches in a confined space where gas is suspected to be.
- e. Receive training in the location and types of shut-off valves installed in your area, from the local authority concerned.

7.12 Water

Water from broken mains may flood basements and other places in which casualties may be trapped. The following precautions must be observed:

- a. Receive training in the location, types and methods involved with water shut off valves, from the Local Authority.
- b. Endeavour to carry portable pumping equipment in the rescue trailer, to enable you to tackle the problem until the arrival of the Public Utility or Fire Services.

7.13 Sewers

Broken sewers may create problems of flooding and escaping gas. Sewer gases can be explosive as well as toxic. The following precautions should be observed:

- a. Never use an open flame.
- b. Endeavour to divert flow away from rescue area, by building a dam or other obstruction to the flow.

7.14 Electricity

Live wires present a serious hazard to trapped casualties and rescue personnel, therefore the following safety precautions should be observed at all times:

- a. Assume all electric wires are "alive" unless known to be dead. The fact that wires do not sputter or spark is no indication that they are dead.
- b. Live wires should only be handled by persons trained in the correct procedures.

- c. Never attempt to move wires on the ground, dangling from trees, poles or hanging slack between poles, except when a life is at stake. Then wires should be moved with DRY objects that do not conduct, such as long wooden boards or ropes.
- d. Avoid pools of water close to live wires - they may be just as dangerous as the wires. Avoid all other conductors such as metal doors and wire fences that may be in contact with high voltage wires.
- e. DO NOT attempt to cut any wires on a pole or underground route. Call the electricity authority.
- f. Normal 240 volt household wiring can be cut using fully insulated and approved cutters, if life is at risk.
- g. The supply to a damaged building should be switched off at the main switch, normally located in the meter box.
- h. Keep vehicles and personnel well clear of areas where wires are down.
- i. Be particularly cautious at night when it is difficult to see wires.
- j. Receive training from your local electricity supply authority in electrical safety and handling techniques.

7.15

L.P.G. Liquid Petroleum Gas

LPG is now in wide spread use in the home, in industry, in vehicles, boats and caravans. It is stored under high pressure eg, propane 1035kPa or 150PSI, and at that pressure is a liquid at room temperature. When released, it expands some 270 times and vapourises to a gas. Escaping gas in basements and confined spaces can create a danger of explosion and the following safety, precautions should be observed:

- a. Do not enter a confined space without protection; if you smell gas, turn off the cylinder and allow time for the area to clear.
- b. Never look for a leak with a match. Use soapy water and if you have a leak, turn off the cylinder immediately.
- c. Be extremely careful of leaking liquid propane or butane. Severe frost bite burns will occur on contact with the liquid.



- d. If a cylinder is leaking liquid while lying on its side, stand the cylinder upright before turning the cylinder off.
- e. If a line is broken and the cylinder cannot be turned off, the line can be cut and crimped with a pair of electricians pliers or similar implements.
- f. A leak which cannot be turned off can often be stopped by binding the area with a wet cloth. This will freeze over and temporarily prevent any further leak. Use substantial gloves when attempting this.
- g. If it is not possible to stop the leak, remove the cylinder to a safe place outdoors - keep people and ignition sources at least 20m away.
- h. If fire is present, keep the cylinder cool by hosing it with a water spray.
- i. If the valve cannot be closed and the gas is burning, keep the cylinder cool by hosing, but do not attempt to extinguish the flame as the build up of burned gases may explode if reignited.
- j. Receive training from the local authority responsible for liquid petroleum gas in your area, on handling techniques of LPG.

#### DEBRIS CLEARANCE

- 7.16 In general, there are two methods by which people trapped under a pile of debris, can be extracted:
- a. by clearance of debris, ie, by removing the debris piece by piece until the victims are uncovered and freed.
  - b. by the construction of tunnels and linking of voids.

In both these operations, a very important principle must be borne in mind. If any one survives at all inside or under a large pile of debris, after a building has collapsed, it is because some heavy timber, a floor or other portion of the structure has fallen or remained fixed, in such a way as to protect this person from the main impact and weight of the debris. In a similar way, the presence of furniture can sometimes protect a casualty. Unless something of this kind has happened, it is unlikely that the casualty will survive. This arching or lean-to may be of a very unstable nature, and, unless great care is exercised, it may collapse. Internal collapse can be avoided only by disturbing the debris as little as possible during rescue operations and by making sure

that, as one portion of the debris is removed, the remainder is not dislodged and allowed to slide or fall in. Careful observance of these principles makes for greater saving in life in two ways: firstly, by minimising the risk of further injury to trapped persons, including possible suffocation by dust; and, secondly, by making for greater speed in the rescue operation, because the less debris that has to be handled, the less work there is to be done in effecting the rescue. The question of how little debris needs to be moved to get rapid extrication, is one which must be left to the intelligence of the leader. Sometimes the removal of the smallest possible amount of debris may not necessarily be the most rapid method of releasing the trapped person. Thus, it may be far quicker, in the long run, to move a heap of debris than to cut through a girder. Such factors as the accessibility of the debris to be removed, the number of rescuers available for the work, the nature of the debris, etc, all have an important bearing on the question of how quickly the job can be done. Whereas speed is unquestionably a most important factor in all rescue operations, speed without safety to both the rescuer and victims, may quite easily defeat its own ends. The ideal is speed with safety.

7.17 When Debris Clearance is Necessary

If no information is available regarding the approximate position of persons trapped in debris, rescue can usually be effected only by general debris clearance (Stage 5). The essential difference between debris clearance as a rescue operation and debris clearance to clear a site is that, while the latter is straightforward and can be done after the life-saving phase by mechanical means, the former demands considerable expedition as well as care to avoid further injury to casualties. In general, the guiding principle is that, so long as there is a reasonable chance of recovering casualties by debris clearance, it must be proceeded with by the rescue parties with unremitting effort. The rescue service must continue at work until it is certain that any persons still buried are no longer alive, and the responsible officer, according to local arrangements, decides that operations can be discontinued.

7.18 Methods of Debris Clearance

When debris clearance is undertaken for rescue purposes, the debris should, if possible, be moved clear of the demolished building, and not merely from one part of the site to another. The practice of 'turning over' debris should be avoided wherever possible, as it usually leads to confusion and unnecessary duplication of work. Debris can be removed by hand or by using receptacles found on the site, eg, dustbins, buckets and wheel barrows and manhandling

these to a selected spot where the debris is to be dumped. When removing debris in a confined space or over obstacles, it is best to form a human chain. The bins, buckets, or other receptacles being used are passed from man to man and emptied at points known to be clear of casualties. It may sometimes be necessary when clearing debris, to cut a lane through it to reach a casualty. Great care must be taken in so doing, to ensure that the sides of the lane do not collapse. These can be made safe, where necessary, by a simple form of timbering and strutting.

7.19

#### Precautions in Debris Clearance

Great care must be exercised in the use of edged tools for the removal of debris, otherwise serious injury may be caused to casualties. Debris in the immediate vicinity of a casualty, or close to a place where a casualty is likely to be, should be removed by hand, using the debris gloves supplied for the purpose, or with the help of the entrenching tool. In this connection, it must be noted that it is sometimes far from easy to recognise a body in a pile of debris, particularly after a fire or when large quantities of lime and dust are present. RESCUERS MUST NOT BE ALLOWED TO CLIMB ABOUT ON TOP OF A PILE OF DEBRIS DURING THE CLEARING OPERATION, UNLESS IT IS ABSOLUTELY NECESSARY. Where it is essential to clear debris from the top downwards, rescuers should be stationed in such a position, that they can pass timbers and other pieces of debris to one another. Timber should be withdrawn from debris only when it is certain that no further collapse will be caused; with the possibility of additional injury or danger to persons trapped. Only when it is reasonably certain that rubble or portions of buildings to be removed do not conceal other casualties should cranes, power shovels or bulldozers be used for debris clearance, to gain access to casualty locations, or to prevent further damage or collapse which may hinder rescue operations. Such heavy equipment should be operated only under the guidance of the officer in charge at the site.

#### DEBRIS TUNNELLING

7.20

Tunnelling is a means used to reach casualties, usually when their location is known. It is slow, dangerous work, and should be undertaken only after all other methods have been exploited. It is used primarily for connecting existing voids. Tunnelling should be

carried out from the lowest possible level, should not be used for general search and must not be aimless. Occasionally, however, tunnelling may be used to reach a point, such as a void under a floor where a further search is to be conducted. (FIGURE 122)

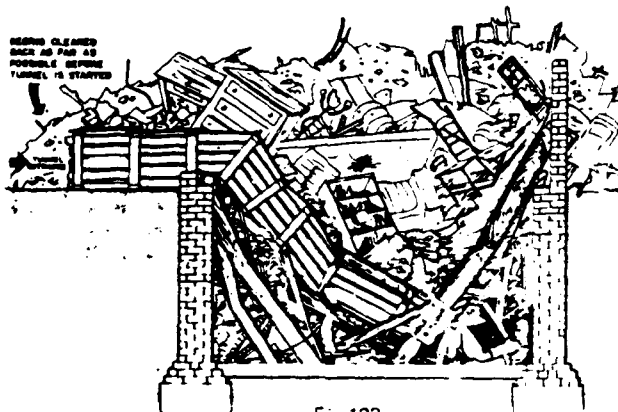


Fig 122.

#### 7.21

##### Tunnel Sizes and Precautions

- a. A tunnel must be of sufficient size to permit rescuers to bring out casualties and should not be constructed with abrupt turns. Tunnels as small as 75 cm wide and 90 cm high have proved satisfactory for rescue work. Wherever possible, tunnels should be driven along a wall or between a wall and a concrete floor to simplify the framing required.
- b. Constructing a vertical shaft may be considered a form of tunnelling for vertical or diagonal access. Usually these shafts are made through earth after debris has been cleared from the surface and are used to reach a point where a basement wall must be breached. Care should be exercised so that shafts are not sunk where water or gas service lines enter buildings. Strata of soil or gravel carrying water should also be avoided.
- c. Debris tunnelling is quite different from tunnelling undisturbed earth, although strutting and bracing are necessary in both methods. The speed at which a debris tunnel can be constructed, varies with the nature of the debris and the size and shape required, because debris is unstable and key beams have to be left in place. The shape and path of a tunnel through debris is often irregular. Thus, a definite pattern of timbering,

as in a tunnel through earth is not possible. The size of timbers used for bracing is governed by the nature of the job and the materials found on site or available from other sources. It is always better to use timbers which are too heavy, than those too light. All earth excavation and tunnels must be shored.

- d. In debris tunnelling, constant watch must be kept for key timbers, beams and girders, disturbance of which could cause movement of the pile and collapse of the tunnel. To avoid any accidental movement, horizontal pieces should be secured by a prop placed under them, still allowing passage of both rescuers and stretchers. Recognizing these key pieces may be difficult, thus bracing everything in the tunnel as the work proceeds, will help prevent accidents. Time spent in careful bracing will not be wasted, when compared to the time required to reconstruct a collapsed tunnel.
- e. When piles of debris are large, shafts may be found useful when sunk to reach a basement level or a basement opening and then tunnelled horizontally to reach a victim. (Fig 123.) It is important to remember that even though materials in the area appear solid, the sides of the shaft must always be braced and timbered and timbers wedged securely into place.

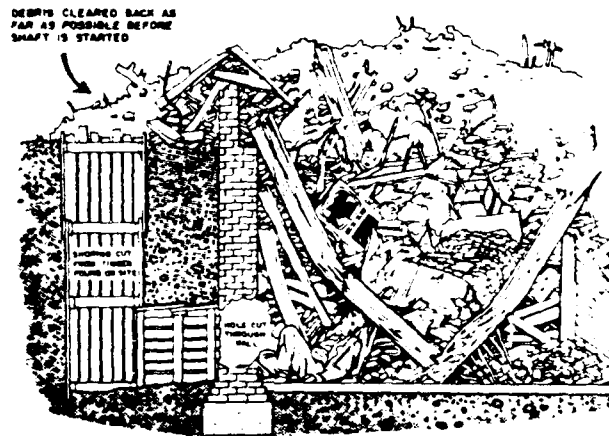


Fig 123.

7.22

Timbering and Lining Tunnels

- a. The recommended method for constructing a debris tunnel is by use of frames and forepoling. Frames are the primary supporting elements of the tunnel and should be prefabricated outside the tunnel and assembled in position as the work progresses. Forepoling is the use of planks or boards driven between the collar and crownbar of one frame and extending beyond the next frame into the debris. Fig 125 shows a longitudinal section and a cross section of a frame tunnel using the forepole method.
- b. To start the tunnel, three frames are constructed, the first frame does not require a collar or spacer blocks at the top, nor do any of the temporary frames. The second and third frames and all other permanent frames in the tunnel, require 50mm spacer blocks and a collar piece set on top of the crownbar. Frame No 3 is set first against a cleared vertical face of debris and then frame Nos 2 and 1 are placed next, at approximately 1 metre intervals and solidly braced. Frame No 1 should be diagonally braced to stakes driven solidly into the ground, about 600mm to 1 metre in front of each strut. After the frames are in place, the top is covered from frame 1 to frame 3, with long pieces of timber such as floor joists, roofing or flooring. (Beyond frame no 3, forepoles need to be long enough to overlap only from one frame to the next).
- c. The sides are lined in the same manner as the roof of the tunnel, driving boards between the frame struts and the rubble. To ensure stability of the tunnel thus far completed, debris should be piled against the sides and over the top. When completed, the frames should be completely covered with the exception of the first frame and diagonal braces.
- d. When debris is removed about 600mm beyond the third frame, the load on the forepoles may make it necessary to construct a temporary frame, firmly wedged under them, until enough debris is removed to permit construction of a permanent frame. The temporary frame should be removed after the permanent frame is properly braced and lined. This procedure is repeated until the tunnel is completed.
- e. Usually, the debris of a demolished structure includes small rubble and dust, which will tend to trickle through gaps in the timbering. At first this may not seem important, but the escape of this material in quantity may disturb the mass of

debris causing internal movement, therefore a tunnel through small loose debris should be boarded as closely as possible.

- f. Rectangular framing has certain disadvantages in debris tunnelling. Since frames are not rigid, unbalanced side pressures may cause them to collapse. In some instances, short debris tunnels with small cross sections may be driven in the form of a closed triangle, using heavy planks keyed together at the ends. (Fig 124) Regardless of the method used, the strutting or lining must be rigid and as tightly wedged as possible. Rigidity and wedging keep the lining in position and prevent it from being broken, by the impact of shifting or moving debris.
- g. When there is doubt regarding the quickest means of access, two or more methods may be tried simultaneously. (eg, a basement may be reached by one or more tunnels or by a shaft from the outside, all being attempted at the same time). Rescue parties may have to remove persons from under collapsed basement walls or from basements still intact but with exits closed by debris. The leader may consider several different approaches. He may, for example, break through the wall from an adjacent basement to reach lean-to spaces. Where ground floors have not collapsed, access can be gained by cutting a hole in the floor from below. In the case of a basement, tunnelling along the top of the floor above and cutting a hole through it, will gain access to the basement below. (Fig 126) Where floors have fallen and a basement ceiling has totally collapsed, a sloping tunnel may be driven from the edge of the debris downwards to the floor of the basement. (Fig 127) A shaft may be sunk next to a building and into the ground along the basement wall, through which a hole into the basement may be made. (Fig 128) If a solid mass of debris is revealed when the hole is cut through the basement outer wall, then the basement ceiling has collapsed. Continue trench or tunnel construction along the outer face of the wall and cut a hole at another point.
- h. If a floor has collapsed, forming a void against one wall and there appears to be a void against the opposite wall, a tunnel may be driven through the debris from the first void toward the opposite wall to reach the second void. It should be remembered that debris tunnelling is one of the hardest tasks in rescue work and should only be undertaken when all other means of gaining access are impractical.

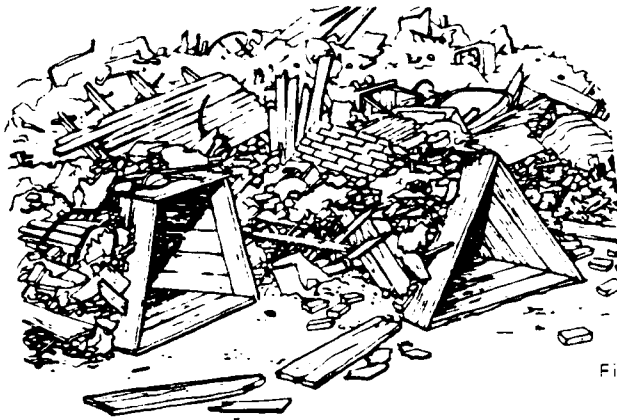
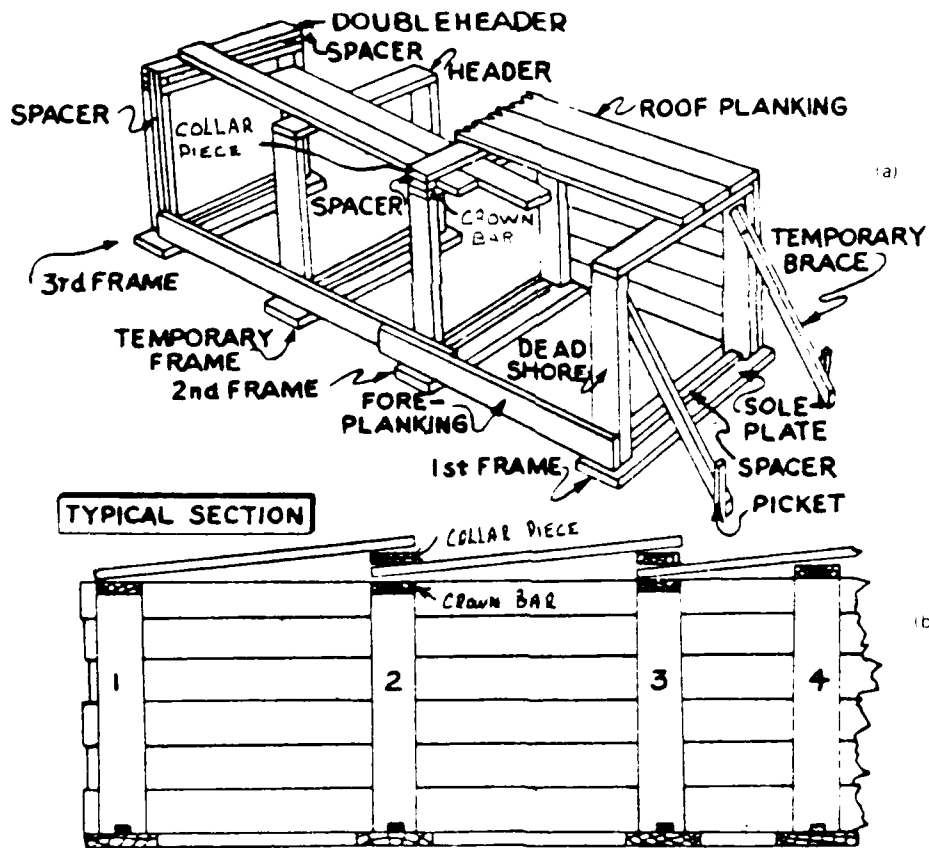


Fig 124.



NOTE 1-2-3 PERMANENT FRAMES  
4 TEMPORARY FRAME

Fig 125.



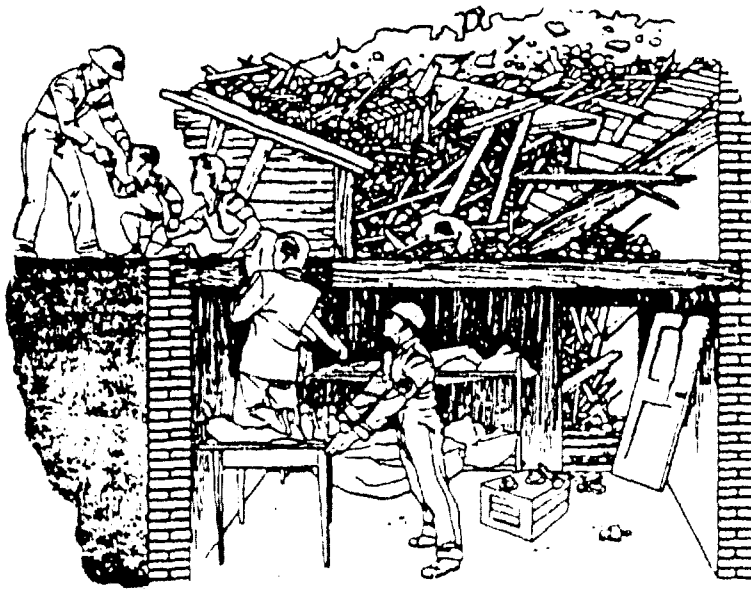


Fig 126.

7.23

#### Lifelines

Tunnel atmospheres known to be contaminated with toxic gases, or deficient in oxygen will require that workers wear some type of breathing apparatus. Whenever a rescue worker is using a mask inside a tunnel, some means of communication is necessary to the outside. In the absence of safe telephones or radios for gas environments, a life line system should be used. A life line is not only a means of communicating, but is a means of locating a worker should a tunnel collapse. Sash cord or similar line is suitable as a life line and can be used to haul out an unconscious worker only if he is a short distance into a tunnel, with a toxic atmosphere. If any attempt is made to pull out an unconscious worker over a long distance or around corners, his facepiece may be dislodged leaving him without protection in a toxic atmosphere. If a worker becomes unconscious, he should be carried out by fellow workers who have been standing by with proper equipment.

7.24

#### Lifeline Signals

Before entering a toxic atmosphere with a mask, a rescue worker should attach a lifeline by a bowline or double figure of eight under one arm and over the shoulder. This will enable him to remain in contact with a person in fresh air, by sending a received rope signal. The line should be kept taut to transmit signals properly. The standard signals are:

- a. One pull - Stop (if travelling). OK (if at rest)
- b. Two pulls - Advance

- c. Three pulls - Retreat, come out at once (from the outside)
- d. Four pulls - Distress, need help.

At least 3 persons should work together, one remains in the fresh air while the other enters. The third worker should be ready to don his mask and enter the area to assist should he require help.

7.25

#### Trenching

- a. Frequently an open trench can be completed more quickly than a tunnel, if debris is not piled too high. Trenching and tunnelling operations may sometimes be combined, with a trench extending into the debris, until a tunnel becomes more practical. All trenches deeper than 1.5m must be shored.
- b. To trench through debris, start by removing the large pieces of timber, stones or other objects from the face of the pile nearest the objects, then clear a way into the debris by shovelling and other hand methods, removing the minimum amount of material necessary to provide a safe passageway. Trenching can be dangerous, because if a trench collapses the worker has little chance of avoiding injury. To avoid collapse, or dangerous movement of the sides of the trench, bracing or some other method of retaining the sides may be required (Fig 127). One satisfactory method is to brace iron or timber sheets against the trench sides.
- c. Material removed from a trench should be piled some distance away and not near the edge, where it can fall back into the trench and have to be moved again. The size of the trench will be governed by its purpose and the nature of the debris.

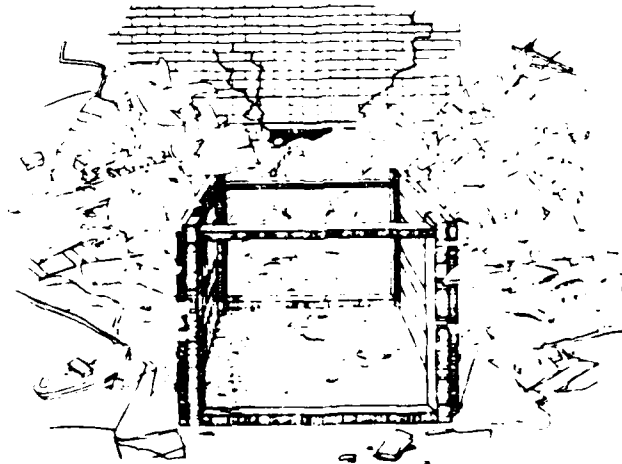


Fig 127.

7.26

Breaching Walls

- a. Many different types of construction will be encountered in rescue operations. These include walls made of brick with lime mortar, stone, concrete, reinforced concrete and concrete block. When cutting through walls, be sure that support beams and columns are not weakened. After a building has been subjected to a blast or similar stresses, parts of the building left standing may appear sound, although badly shaken and cracked. Therefore when cutting or hammering away wall sections, care must be taken to prevent further collapse.
- b. Openings large enough for rescue purposes can usually be made in brick walls, without masonry falling. The bricks should be removed, so that the opening is arch-shaped.
- c. Concrete walls and floors, especially when they are reinforced are difficult to cut through. Jack hammers or other power tools may be necessary and the local authority should be contacted in this regard. In all walls and floors, except concrete, the best method is to cut a small hole and then enlarge it. With concrete, however, it is better to cut around the edge of the section to be removed. If the concrete is reinforced, the reinforcing bars can then be cut by a hacksaw, torch, or bolt cutters and the material removed in one piece. If an oxy acetylene torch is used, be sure explosive gases are not present and that flammable materials are not ignited. A fire extinguisher should be kept nearby.

7.27

General Precautions

- a. Where dust is a problem, dust masks, handkerchiefs or cloths worn over the nose and mouth will prevent serious inconvenience.
- b. Ensure there is adequate ventilation and wear self contained breathing apparatus in areas suspected to contain toxic fumes.
- c. Dust goggles should be worn to save the eyes from dust and grit.
- d. The rescuer working at the face should have a lifeline attached.
- e. Debris gloves must be worn, as they save unnecessary minor injuries.
- f. Extra care must be taken, especially in the use of edged tools when nearing a trapped person.
- g. Protective helmets will be worn at all times.

## CHAPTER 8

### EMERGENCY ROOF COVERING, TEMPORARY SHORING AND ELEMENTARY DEMOLITION

#### EMERGENCY ROOF COVERING

8.0 The purpose of providing emergency roof covering to storm damaged roofs, is to minimise further water damage to the inside of the structure and to provide temporary protection from the elements for the occupants. Emergency covering is not intended to be a long term remedy to leaking roofs, nor will it offer total protection against further storms.

#### 8.1 Personal Dress and Safety Rules

- a. Workers involved with climbing onto roofs must at all times wear rubber soled boots or shoes and be aware of their own capabilities, when working at heights. Much of the work is physically demanding and can be dangerous to the untrained worker.
- b. Other standard issue protective dress is recommended, because broken roofing material can inflict cuts and abrasions. All such injuries must be treated rapidly.
- c. Following heavy rain, roof tops are slippery, particularly older fibro and tiled roofs which tend to be covered with a slippery mould. Extreme care should be taken and life lines worn in these conditions.
- d. When walking on a roof, follow the batten lines or overlaps, for some roofing materials can and do collapse under weight.
- e. Do not use the gutter around a roof as a hand or foot hold, they are often of flimsy construction or badly corroded.
- f. Before climbing onto a roof, check that the power wiring from the street pole to the house is intact and not lying on the roof at any point. If in doubt, don't climb on the roof - have the electricity authority check it out.

#### 8.2 Surveying the Damage

- a. Party leaders should resist the temptation to have the team climb onto a roof and immediately cover it with a tarpaulin. Tarpaulins, in any major disaster will be in short supply and should only be used where an alternative emergency repair is not possible.

Section 8.5 lists many alternatives for providing emergency repairs.

- b. Survey the house and ensure that there are no apparent electrical hazards and that the structure appears sound before sending team members onto the roof.
- c. Check with the householder prior to effecting any emergency repairs to (1) gain permission (2) determine the well being of occupants.
- d. Report any smell of gas or petrol or electrical hazard to the Headquarters or appropriate authority.
- e. Party leaders should realize that the occupant may react angrily when approached and want to know what is being done about his or her problem. This is a normal reaction, for some people, following a disaster and should not be taken personally. Effect the emergency repairs and give the occupant assistance in contacting the welfare support, which would be operating in the area. Don't get involved in an argument.
- f. Do not discuss the quality of various roofing designs and materials with the householder or media. If you have views, express them only to your immediate superior.

### 8.3

#### The Structure of Roofs

The types of roofs, structure and coverings are many and varied, but the structure, basically, is that rafters support purlins which in turn support battens. The roof covering is attached to the battens.

Roof coverings range from corrugated iron, through clay, cement, plastic, and aluminium tiles, cliplock or paneldeck sheets, aluminium sheeting, fibrocement, fibreglass and shingles of all materials. It is not possible in this publication to list the manufacturers, local authority and various State specifications for installation of each respective roof covering. Rescue parties involved with emergency repair of roof tops, are advised to consult with the local Building Inspector or Master Builders Association, to brief members on the relevant types of roofing, safe and unsafe practices, as part of the Unit's normal training activities.

### 8.4

#### Preparation Prior to Covering

Torn tarpaulins are of little use to anyone. It is important that sharp protrusions, such as the corner of roofing iron, old nails, broken battens, etc, are removed prior to covering the roof. This can normally be achieved with a wrecking bar and claw hammer.

8.5 Types of Emergency Coverings

The following are just some of the articles which can be used to effect emergency roof repairs.

Polyethylene High Density Tarpaulins

Canvas Tarpaulins

Tent Pieces

Sheeting, Polyethylene Low Density

Sealing Compounds

Hessian Bags

Plastic or Garbage Bags

8.6 Polyethylene Tarpaulins, Canvas Tarpaulins, Tent Pieces

When covering a roof with tarpaulins or tent coverings, care must be taken to overlap the coverings correctly. Always start laying on the downward side of the roof and tie off securely top and bottom. Ensure that the covering on the "up" side, overlaps the lower covering by at least 15cm and is tied down securely. (Figure 128)

Coverings laid side by side should also be overlapped by at least 15cm. (Figure 129)

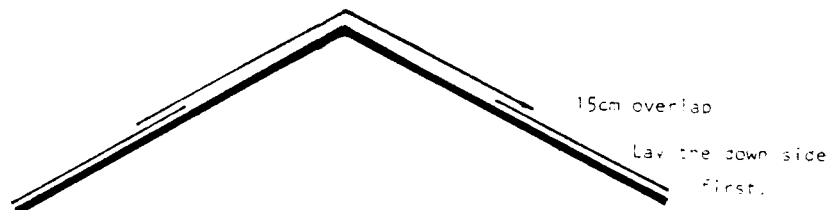


Fig 128.

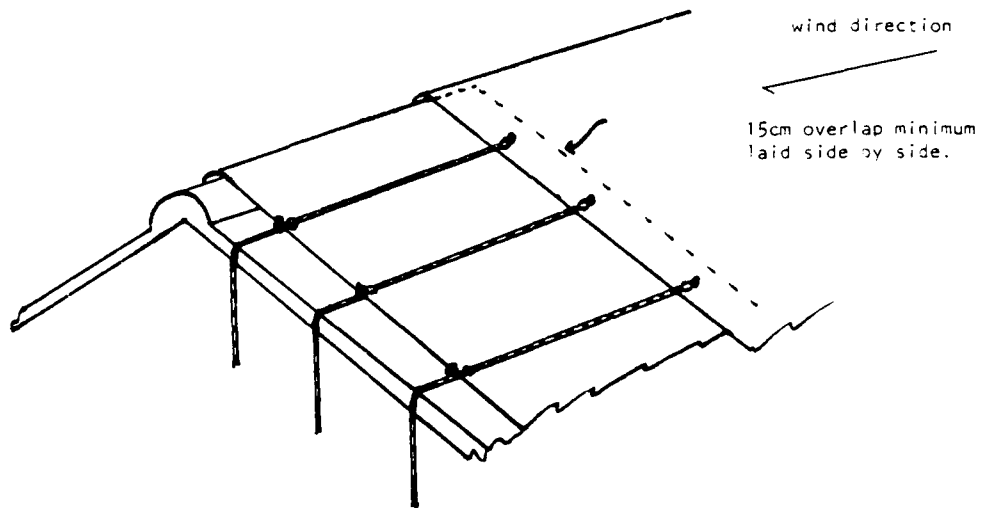


Fig 129.

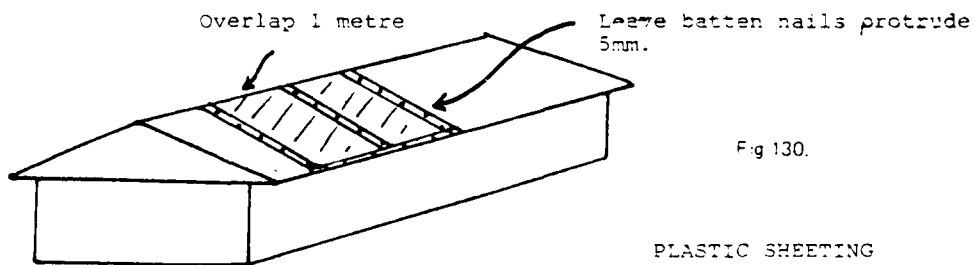
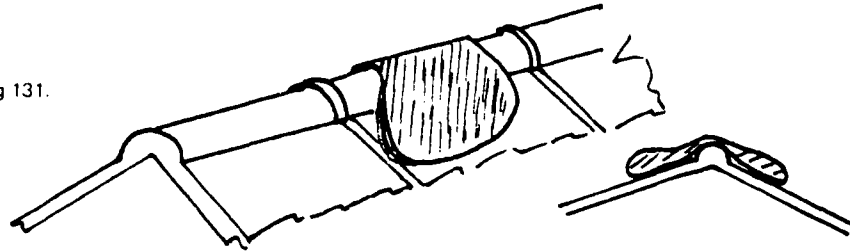


Fig 130.

PLASTIC SHEETING

Fig 131.



HESSIAN OR PLASTIC BAGS

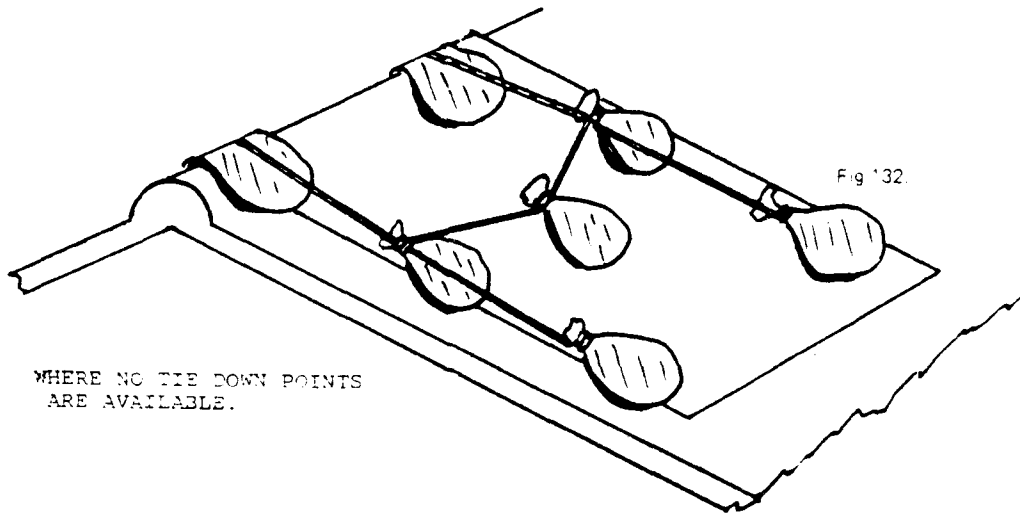
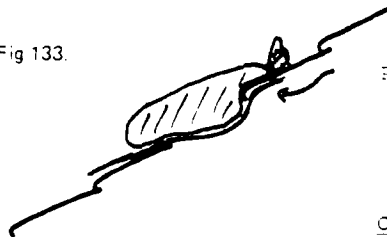


Fig 132.

WHERE NO TIE DOWN POINTS  
ARE AVAILABLE.

Fig 133.



PLASTIC SHEET TUCKED  
UNDER TILE.

COVERING HOLES



8.7 Plastic Sheeting

On roof tops where large areas of roofing materials have been blown off, lengths of plastic sheeting and wooden battens can be used to great effect. Ensure that all sharp protrusions, such as nails are removed then lay the sheeting from the top to the gutter, in strips making sure at least 1 metre of sheeting overlaps the ridge capping.

Anchor the top end with a batten and stretch the plastic firmly. Anchor the lower end of the sheeting with a batten, but do not anchor the sides until the adjoining sheets are laid and overlapped by approximately 15cm. The one batten can then anchor both adjoining sides (Fig. 130).

Do not drive the nails right home, but leave about 5mm protruding to facilitate removal.

8.8 Sealing Compounds

Many commercial preparations exist on the market, which can be used effectively to repair minor damage to roofing material, particularly that damage caused by hail or flying debris. Cracks in tiles, small holes in fibro, iron, aluminium can be repaired with greater speed using a sealant. Mineral fibre reinforced asphaltic sealing compounds such as "Hydroseal" or adhesive sealing strip, such as "Flash Band" have proved to be effective.

8.9 Hessian Bags

A hessian bag, when half filled with sand, makes an excellent saddle for holding broken ridge capping in place (Fig. 131).

The same "saddle" principle can be used to hold down plastic sheeting, over a ridge capping.

Hessian bags are also of considerable value as weights, to hold down sheeting of tarpaulins on roof tops, where tying down is not possible or effective (Fig. 132).

8.10 Plastic or Garbage Bags

These items are readily obtainable from the householder in most cases and when filled with soil from the garden, can be used in all the applications previously described for hessian bags.

When used with a sheet of plastic, holes in a roof can be effectively covered (Fig. 133).

8.11 Coverings Generally

The party leader should at all times consider the options open to him for emergency repairs. It is

quicker to renail a galvanised iron roof that has not been too badly damaged, than to place a temporary covering over the roof. The options open to the leader when undertaking emergency repairs, are limited only by his or her imagination.

#### TYING DOWN

- 8.12 There is little point in covering a damaged roof with a tarpaulin, if at the next slightest wind the covering is going to be blown off.

Tying off and tensioning are extremely important. It is simple if done correctly and will last until permanent repairs are effected, but if not handled correctly, will become a continuing source of annoyance to both householder and Emergency Service alike.

Ensure the uppermost sheet is towards the windward side of the building. 5mm polypropylene rope is recommended for tying down tarpaulins. It is comparatively low cost, can be handled easily, can be cut to desired length and is expendable.

- 8.13 Connection to the Tarpaulin

The only satisfactory methods of tying to the eyelets in a tarpaulin are:

- a. a bowline
- b. a figure of eight loop
- c. a stopper knot
- d. a splice.

Do not use a slip knot or any tight knot. Remember, someone following later, must recover that tarpaulin and remove the rope.

Tight knots and slip knots tend to cut into the eye and cause damage to the tarpaulin.

- 8.14 Extending the Length of Rope

Some tarpaulins have ropes spliced to them by the manufacturer. These are invariably too short and must be extended. A sheet bend or double fishermans knot, are the only acceptable joining knots.

- 8.15 Tie Down Points

Ropes from tarpaulins can be tied off to any strong point available such as:

FENCES

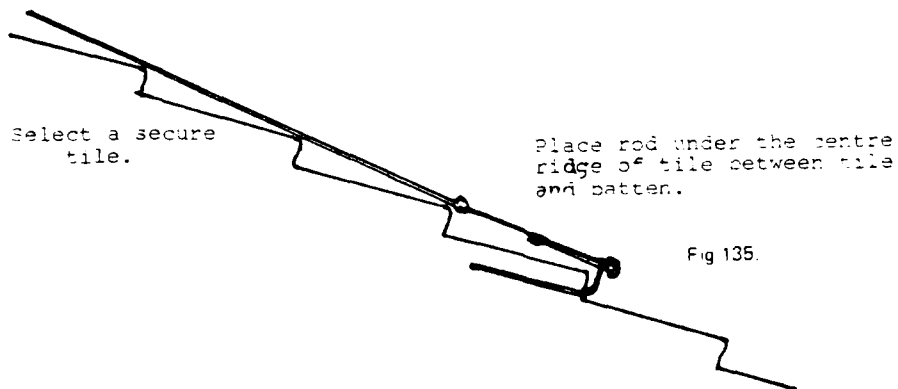
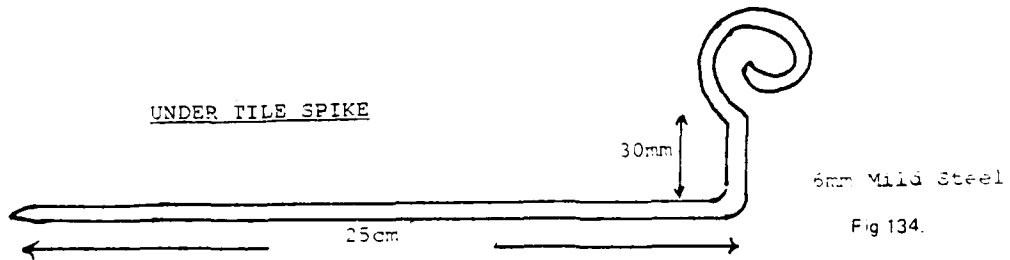
DOWN PIPES

BARE RAFTERS

NAILS DRIVEN INTO FACIA PANELS

UNDER TILE SPIKES (Fig. 134 & 135)

EDGE AND GUTTER HOOKS (Fig. 136 & 137)



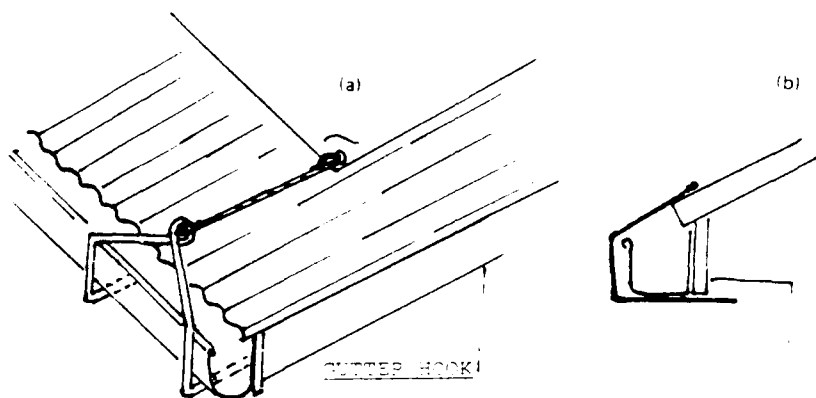


Fig 136.

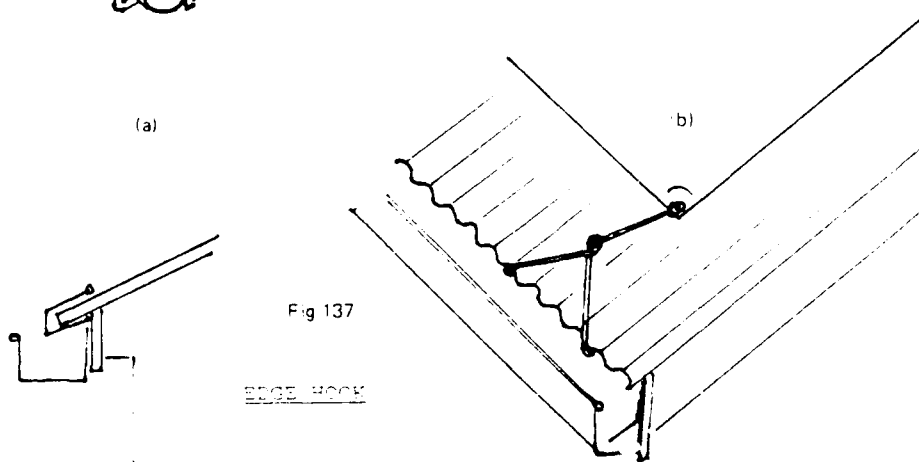


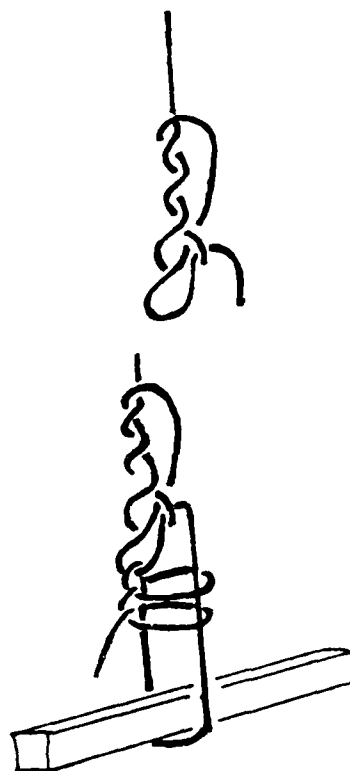
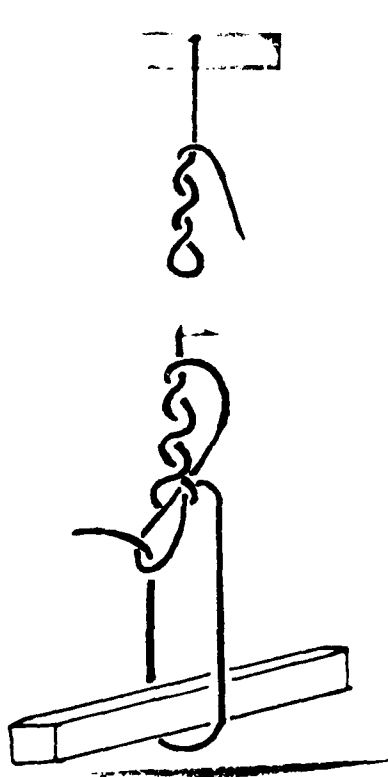
Fig 137

All lines should be tied with an adjustable hitch, so that the covering can be tensioned correctly and undone easily when required.

(a) TWIST THE ROPE AND  
FORM A LOOP.

(b) PUT A LOOP THROUGH  
THE LOOP IN THE TWIST.

Fig 138.



(c) PLACE RUNNING END ROUND TIE DOWN  
AND PUT THROUGH THE LOOP. PULL  
TO TENSION.

(d) TIE OFF WITH TWO HALF HITCHES.

Figure 138 demonstrates a single pull hitch which is  
simple to tie in 5mm rope and is easily removed.

DO NOT OVER TENSION - TARPAULINS CAN BE TORN.

8.16

SUSPENDED TIES

Where no tie off points are available, weights can be suspended from ropes to supply the tension required. Sandbags, garbage bags, lengths of pipe or timber etc, can be utilised in this manner. (Figure 139)

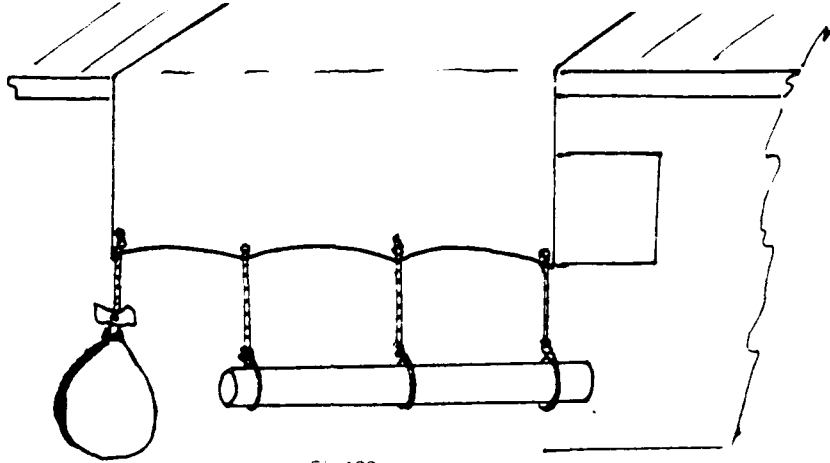


Fig 139

SUSPENDED TIES

As a last resort, a rope can be run completely around the house and tied off. Ropes from the tarpaulin can then be tied off to that rope. (Figure 140)

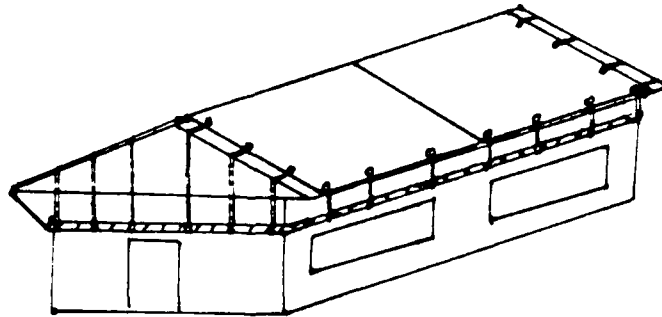


Fig 140

8.17 ACCOUNTABILITY

It is the party leader's responsibility to obtain a receipt for tarpaulins left with the householder. The householder should be advised that tarpaulins left on the roof, are recoverable and must not be destroyed or taken away by the builders, when they repair the roof. Details of resources left on the site, should be given to the leader's headquarters.

8.18 LIFE LINES

In any situation where the member working on the roof feels insecure, a basic life line should be used. This is simply 12mm lashings or synthetic line, joined together and tied off to a strong point on the ground, or on the roof (on the opposite side of the ridge line, to that which is being worked on). It is measured out to ensure it is not longer than the opposite gutter line and tied off to the members waist with a bowline or figure of eight loop.

TEMPORARY SHORING

8.19 Shoring undertaken by rescue parties, should normally be limited to that required to:

- a. enable emergency personnel to carry out their duties with safety;
- b. prevent further injury to casualties;
- c. obviate danger to the public through the collapse of the building into a highway or other public place.

Rescue parties should not, therefore, spend time in erecting elaborate shoring at incidents; they should erect only such temporary shoring, as is necessary to meet urgent requirements.

Generally the materials for improvised and temporary shoring, should be obtained from damaged buildings. Most buildings contain timbers of suitable sizes, especially if two or more pieces are nailed together to form the required lengths and cross sections. Such building up, should always be done with the timbers laminated, spiked together and with the joints staggered.

8.20 Definition

A temporary shore, as applied to rescue work, is a series of timbers erected so as to strengthen and prevent further collapse of any part of the building.

8.21 General Precautions

The purpose of shoring is not to force the damaged wall or ceiling back into its original position, but rather to prevent further movement.

Any attempt to force things may result in further damage. It is, however, essential that all shoring be secured into its position. This should be done gradually and without shock to the structure, using the lever and wedge method rather, than by hammering into position.

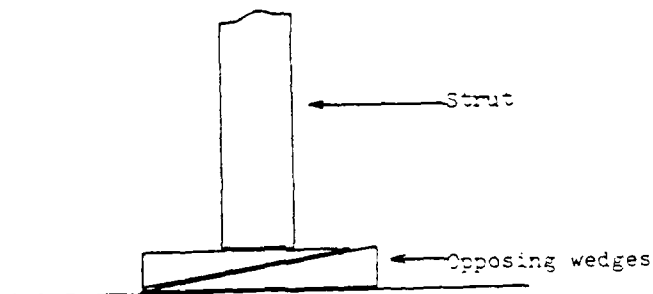
8.22 Folding Wedges

The main shoring timbers must be gently secured into position, and by far the best method of achieving this is by the use of 'folding' or 'opposing' wedges.

The wedges should be formed from timber found on site, and when two wedges are placed in opposition the grain of the timber should run along each of the contacting faces, rather than meeting as end grains. (Figure 141)

Fig 141

Opposing Wedges To Tension a Strut



8.23 Types of Shore

There are three main types:

- a. Raking;
- b. flying;
- c. Dead or Vertical.



8.24

Raking Shore

- a. This is used to prevent a wall or vertical part of a building, from bulging or falling away.  
(Figure 142)

Principal Parts

The principal parts of a raking shore are the raker, wall-plate and sole-piece or sole-plate. Other items necessary for the erection of a raking shore are cleats, struts (or braces) and wedges. Recommended sizes for these are given below:

<u>Max. Height</u>	<u>Raker</u>	<u>Wall-plate</u>	<u>Sole-plate</u>
4.5m	100mm x 100mm	240mm x 50mm	240mm x 75mm
6m	125mm x 125mm	240mm x 75mm	240mm x 75mm
7.5m	150mm x 150mm	240mm x 75mm	240mm x 75mm

Strut

100mm x 50mm

100mm x 50mm

150mm x 100mm

NOTE: These can be either of solid timber, size as stated, or can be made up by different size timbers, ie, two 100mm x 50mm joists strapped and dogged together, would form a 100 x 100 raker.

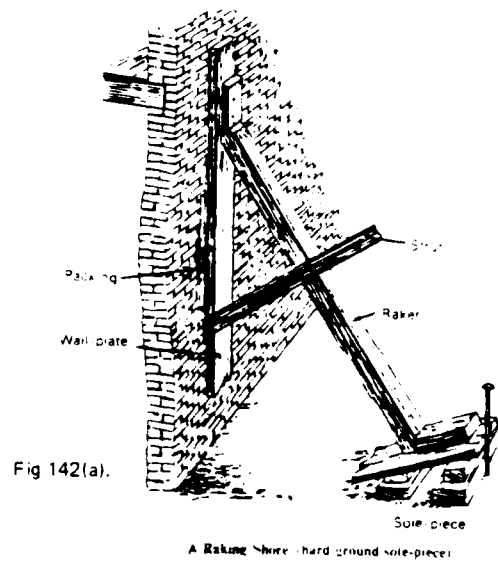
- b. Method of Erecting

A cleat is first nailed to the wall-plate, at a joint just above the common meeting point of the raker and load bearer.

- c. The sole-piece should be placed in such a position, that it takes the thrust of the raker at an angle exceeding a right angle, so that when tightening up is done, a right angle is formed. This tightening up, should never be done with a hammer, but a small rebate should be cut from the foot of the raker. The rebate enables a lever to be inserted to tighten it up, or folding wedges could be inserted between the foot of the raker and the cleat. Soft ground can be excavated sloping towards the unsafe wall, in order to give the necessary angle. On hard ground, the sole-piece will have to be built up to the required angle and spiked or wedged to prevent movement outwards. Alternatively, a sole-plate may be constructed by using a plank as wide as the wall-plate. When the bottom of the wall plate is touching the ground, it could be allowed to rest

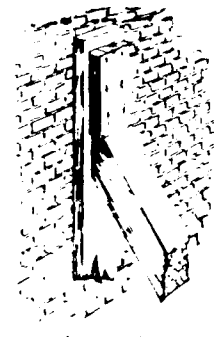
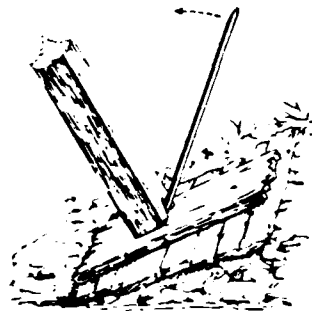
on the end of the sole-plate nearest the wall and later a cleat may be nailed into position in the right angle thus formed. Further along the sole-plate approximately 50mm away from the foot of the raker to allow for the insertion of folding wedges between the cleat and the raker. When the wedges are placed in position and tightened, care should be exercised to ensure that this action does not allow the wall-plate to ride up the wall. As a safety measure, the end of the sole-plate outside the raker, should be secured by a stake or spike to prevent movement.

- d. Wall-plate. The wall-plate should be, as far as possible, continuous throughout its length and when used against a bulging wall should be backed with timber pieces in order to give it continuous bearing throughout its length. The cleat having been nailed in position, the wall-plate is now held against the wall while the raker is being fixed.
- e. Raker. The top of the raker is then placed underneath the cleat and the foot placed on the sole-piece. The whole structure is then gently levered into the correct position and a cleat is nailed on the sole-piece behind the raker. Any irregularities in cutting may be remedied by the use of wedges.
- f. Strut (or brace). The strut or brace is then fixed. This prevents any movement by the foot of the wall-plate and checks the wall-plate from riding up the wall under stress. The strut should be spiked and if necessary dogged to the raker and wall-plate.
- g. General. Care should be taken when setting out, to ensure that the centre line of the joint bearing meets at a common point. To prevent the wall-plate from riding up the wall, use may be made of window sills, oversailing courses or needles placed in ventilator bricks. The best angle to achieve when locating the raker is 30° at the head and 60° at the foot.



Footings a Raking  
Shore in soft ground

Fig 142(b)



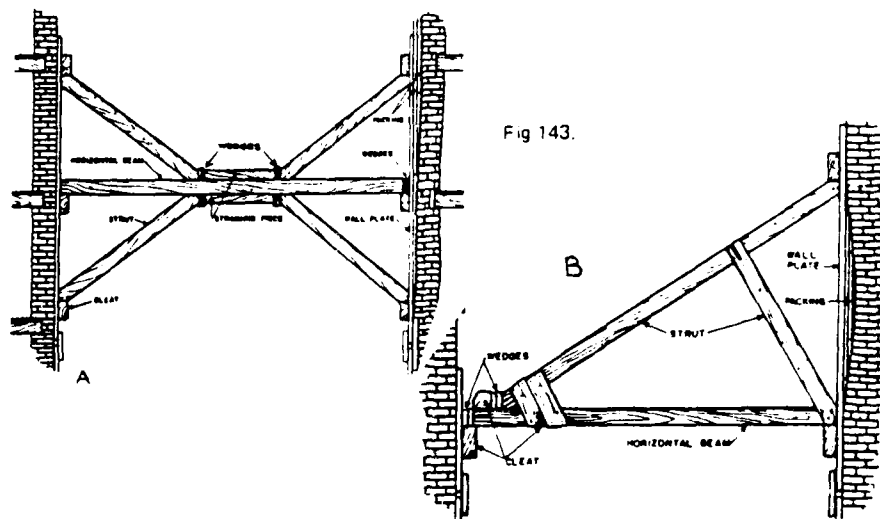
Head of a Raking Shore  
Fig 142(c).

8.25 Flying Shore (Fig. 143)

- a. This is used between the wall of two buildings, the sound wall giving support through the shore to the damaged wall.
- b. Principal Parts. The principal parts are the horizontal beam, wall-plate and struts. Other items necessary for the erection of the Flying shore are cleats and wedges and straining pieces. Suitable sizes for these are given below:

Max. Span	Horizontal Beam	Wall-plates	Struts
3m	150mm x 100mm	175mm x 50mm	100mm x 100mm
4.5m	150mm x 150mm	175mm x 50mm	100mm x 100mm
6m	150mm x 150mm	240mm x 50mm	100mm x 100mm

- c. Method of Erection. The cleats are nailed to their positions on the wall-plates, the first pair to support the horizontal shore and the other pairs to support the struts. Ensure that the cleat for the horizontal beam adjacent to the sound wall, is thick enough to allow for the folding wedges and a good overlap by the beams. Endeavour to give the horizontal beam equal cleat-bearing surface at each end. The struts should be set at an angle not greater than 45 degrees to the horizontal beam, and should be kept apart on the horizontal beam by straining pieces. The length of these straining pieces is determined by the length of the horizontal beam. It is advisable to set the job out on the ground before erection, so that attention can be given to measurements and angles. While the wall-plates are being held in position, the horizontal beam with the straining pieces temporarily lashed to it, is placed on the centre cleats and tightened by folding wedges inserted between the shore and the wall-plate. The struts are next placed into position between the cleats and the straining pieces, being tightened by wedges. If wedges are necessary to the lower struts, they should be placed between the tops of the lower cleats and the lower struts. Timber dogs may be used to brace the shore rigidly.
- d. General. The centre line of the horizontal beam and struts should meet at a common point. The wall-plates should be continuous throughout their length - packed between the wall and the wall-plate, if necessary in order to give a continuous bearing. It is not advisable to erect a flying shore between two walls at a distance greater than 7.5 metres apart. Flying shores should be placed along a wall, at intervals of 2.5m to 3.5m, depending upon the circumstances and the degree of damage.



8.26 Dead Shore (Fig. 144)

- a. A dead shore carries the vertical load of the wall or floor, and should be erected at all times when rescue personnel are working below a dangerous wall or ceiling, or on a floor above, which is in danger of collapse. A careful assessment of the situation should be made, before work is commenced and if in doubt place dead shores in position as required.
- b. Principal parts. The principal parts are the sole-piece, head-piece and vertical or dead shore. Other items used are braces, wedges and logs.
- c. Methods of Erecting. The sole-piece is laid down in position, taking care that it is placed on a solid foundation. The head-piece is held in position and the vertical or dead shores, are then placed upright between the head-piece and the sole-piece and securely wedged by a pair of folding wedges, inserted between each dead shore and the sole-piece. These wedges should be tightened simultaneously.

In using folding wedges, care should be taken that the wedges are 'married' before tightening is attempted. ('Married' means that one point overlaps the other after insertion of the wedges).

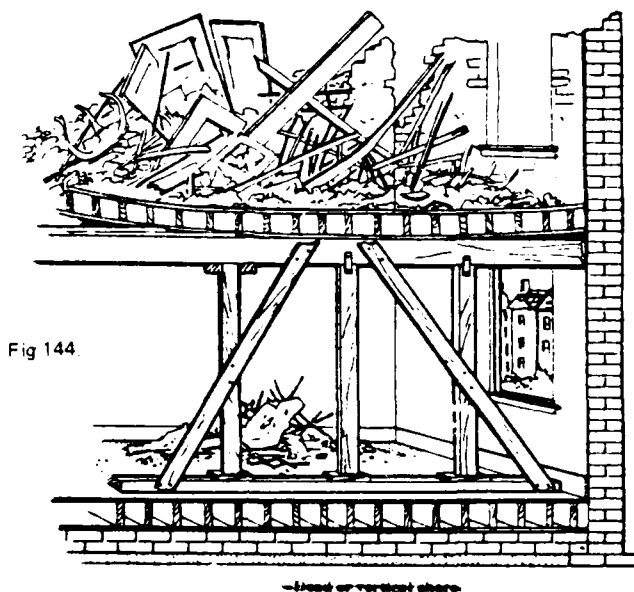
Where braces are necessary, they should be long enough to extend diagonally, from the head-piece across the shore to the sole-piece and nailed to each in turn.

- d. General. It must be remembered that vertical or dead shores may be carrying the full weight of the structure above, whereas raking and flying shores mainly oppose the overturning tendency. It is very important, therefore, to have a solid bearing for the sole-piece. The sole-piece must be as broad and as long as possible in order to spread the load. There is no rule laid down, as to how many verticals should be constructed, but common sense should dictate this.

When cutting the verticals, remember that the length of each is the distance between the ceiling and floor, less the thickness of the head-piece, the floor-plate and about two-thirds of the thickness of the wedges when folded. It is fairly difficult to estimate what load a vertical or dead shore will carry, but the following rules may help:

- i. The shorter the length, the greater the load carried.
- ii. The strength is increased, if the ends are cut square to fit on the head and the sole-piece.

Care must be taken not to drive wedges too tightly or they will have a lifting effect.



8.27

Strutting of Openings (Figure 145)

When the walls near the window and door openings are unsafe and are to be shored up, or when the head or sides of such openings are damaged, it is a sensible precaution to strengthen the opening by strutting. The uprights and struts may be 'pinched' into position, or cut shorter and tightened with folding wedges. Pairs, not single wedges, should be used. The size of timber usually used on this class of work, varies from 100mm x 50mm to 175mm x 75mm, according to the size of the opening. If an arch has to be supported, timbers will have to be shaped or packed to fit its entire underside, depending on the shape that the arch has assumed when damaged.

Many methods of strutting may be employed, but, whether the opening be window or door, sufficient room must be left between the struts for a casualty to be brought through or to enable a rescue to be effected.

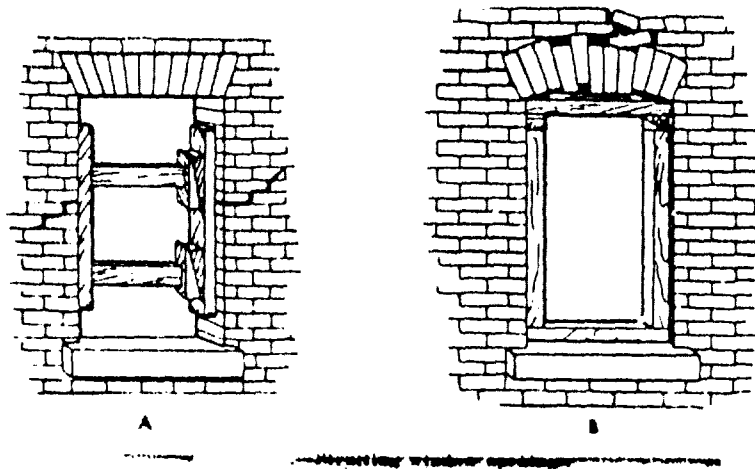


Fig 145.

#### ELEMENTARY DEMOLITION

8.28 Demolition is a highly skilled operation rarely undertaken by rescue parties. Only elementary demolition of the most urgent nature, is undertaken by the rescue service, ie, when lives are in danger.

Two methods available to rescue parties are:

- a. Piecemeal removal, working down from the top.
- b. Pulling over by cable attached to vehicle or winch, or by manpower.

Methods adopted depend upon such factors as:

- a. Accessibility to enable tackle to be firm.
- b. Degree of urgency.
- c. Space available.
- d. Stability of building.

Piecemeal demolition is the safest, but it takes longer. When using the cable method, pack out the noose to prevent cutting through a structure and to pull a section, not pieces, which may require to be undercut to fall in desired position. Note that all demolition is likely to create additional dust.



## CHAPTER 9

### LIGHTING AND POWER EQUIPMENT

#### MOTOR DRIVEN A.C. GENERATORS

9.0 Numerous brands and types of Motor Driven A.C. Generators are available commercially (sometimes called Alternators), but are basically similar in construction, ie, within a frame or case, a motor drives an alternator to produce 240 volts AC (Alternating Current). The ability of this alternator to deliver current, is dependent on its power output rating in WATTS. This is a power rating which is also often rated in KILOWATTS (kW) ie.

$$\frac{\text{WATTS}}{1000} = \text{KILOWATTS}$$

These are commonly used methods to describe the same thing - the POWER OUTPUT OF THE GENERATOR.

As it is detrimental to a generator to operate more appliances or lights than the generator can handle, a rescue member must know how to calculate the amount of power, that a particular appliance will draw from the generator:

- a. Lights and heating appliances are normally rated in WATTS, therefore when using lights only, it is a simple matter to add the wattage of the number of lights being used and subtract the figure from the generator capacity, to calculate the power still available.

eg. Assume 3 banks of lights, each drawing 500 watts are being used.

TOTAL WATTAGE IS 1500W

If a generator was rated at 2500 watts or 2.5kW, it can be seen that there is still 1000 watts capacity left in the generator.

- b. With appliances using electric motors eg. drills, chain saws, refrigerators, fans etc; these appliance often indicate the amount of CURRENT drawn from the generator, not the power. This is usually found on a compliance plate on the appliance and is rated in AMPERES or AMPS.

ie.  $\text{POWER (IN WATTS)} = \text{VOLTAGE (240V)} \times \text{CURRENT (AMPS)}$

If an electric chain saw is rated at 5 AMPS, the power it draws from the generator is

$\text{POWER (IN WATTS)} = 240 \text{ VOLTS} \times 5 \text{ AMPS}$

$= 1200 \text{ WATTS}$

- c. It can be seen that this particular chain saw can be run from a 2500 WATT (2.5kW) generator, but not from a 1000 WATT (1.0kW) generator.

The chain saw could also be used in addition to two 500 WATT bank of lights ( $1200 + 1000 = 2200$  WATTS), but not three banks of lights, from a 2500 WATT generator. Many rescue teams calculate the POWER rating of each appliance likely to be used, from a generator and clearly mark this figure on the appliance to save time and possible overload problems during an emergency.

NOTE: Motor starting current is approximately 3 times the rated full load current of electric motors. When selecting generators for motor starting, this factor should be considered to avoid overloads.

#### SAFETY IN THE USE OF GENERATORS

- 9.1 Wherever there is a combination of heat, petrol and electricity a potentially dangerous situation exists. The following list of Dos and Don'ts should be observed when operating any generator:
- a. Do not place combustible material near the generator.
  - b. Do not place explosive materials (petrol) near the generator.
  - c. Operate the generator on a stable, level surface to prevent fuel spillage and excess vibration.
  - d. During use, keep the generator at least 1 metre away from buildings and other equipment.
  - e. Avoid placing anything around the generator or covering it up. Generators are normally air cooled and require a free flow of air to prevent overheating.
  - f. Always stop the engine before refuelling.
  - g. Be careful not to spill fuel on the generator. If fuel is spilt, wipe the machine dry before starting the engine.
  - h. Do not fill the fuel above the designated level.
  - i. Do not smoke when refuelling or expose the process to naked flame.

- j. Do not operate the generator in locations with poor ventilation such as tunnels, under houses, inside tents etc.

Carbon Monoxide poisoning can result from a build up of exhaust gases.

#### 9.2 Electrical Safety Precautions

The electrical output of most generators is as potentially lethal, as is the normal 240 volt outlet in the home. The following safety points should be observed:

- a. Do not operate the generator with wet hands and exercise great care when operating in wet conditions.
- b. Keep the generator dry. A wet generator may generate poorly, be hard to start and is a safety hazard.
- c. Do not connect the generator to the household wiring system, unless approval has been obtained from the Electricity Authority and an approved isolation system has been installed.
- d. Have all appliances, cords, plugs, sockets, etc periodically checked for safety. Repair any worn or frayed cords.

#### 9.3 Generator Operational Checks

Before operating any generator, read the manufacturer's instruction:

- a. Does the motor have oil in the sump? Is it the correct type and quantity?
- b. Is the motor two stroke (oil and petrol fuel mix) or four stroke? (Unleaded Petrol). Ensure the correct fuel is used.
- c. Are the starting procedures for the machine known? Is the location of the choke; are power cords removed for starting? If there an on off switch? Is there an adjustable throttle? How are the revolutions set for 240 VOLTS output? Read the instructions before starting the machine.

#### 9.4 Generator Maintenance

The maintenance of a generator is an important factor, if reliable and long service is to be expected.

In the absense of any Manufacturer's recommended service routine, the following information gives an indication of the maintenance routine required on a typical generator:

<u>ITEM</u>	<u>ACTION</u>	<u>FREQUENCY</u>
ENGINE OIL	CHECK LEVEL	ALWAYS BEFORE USING
ENGINE OIL	CHANGE	6 MONTHLY OR 120 HOURS OPERATION
AIR CLEANER	CHECK AND CLEAN IF NECESSARY	ALWAYS BEFORE USE
AIR CLEANER	CLEAN	3 MONTHLY OR 50 HOURS OPERATION
FUEL STRAINER	CLEAN	6 MONTHLY OR 120 HOURS OPERATION
SPARK PLUG/S	CLEAN/READJUST	3 MONTHLY OR 50 HOURS OPERATION
* IGNITION TIMING	CHECK/READJUST	12 MONTHLY OR 300 HOURS OPERATION
* VALVE CLEARANCE	CHECK/READJUST	300 HOURS OPERATION
* COMBUSTION CHAMBER	CLEAN/RELAP VALVES	300 HOURS OPERATION

\* The items marked \* should only be carried out by a Service Dealer.

#### 9.5 Storage

- a. Many generators used by the Emergency Services have periods where they may not be used for some considerable time. If this is the case, always store the generator with the piston in the compression stroke, thus closing both the inlet and exhaust valves and also closing the contact breaker points. This procedure prevents corrosion of the combustion chamber, corrosion of the contact points and prevents the valves from sticking open when next the generator needs to be started. The compression stroke can be found by pulling the starter cord or turning the starter pulley until it becomes hard to turn (the piston is rising on the compression stroke), then continuing to turn the pulley until just before the top of the piston stroke.
- b. Drain the fuel from both the tank and the carburettor. Fuel left for long periods in the carburettor can cause a chemical reaction which adversely affects carburettor components.

## LIGHTING

9.6 Working at night can increase the dangers involved with rescue work due to shadows, glare and poor vision associated with artificial lighting systems. Rescue members should experience the night rescue situation in training and experiment with various lighting positions, so as to eliminate as much as possible the three hazards mentioned.

### 9.7 Positioning Lighting

Little in the way of guidance can be given when lighting the rescue scene because all scenes vary greatly, but the following points are valid for most situations:

- a. Position lights as high as possible to illuminate the area required, without creating eye level glare problems. Lights positioned at slightly above eye level, to the ground will cause temporary loss of vision to the rescue worker every time he inadvertently looks in the direction of the light. Endeavour to position them above 3 metres high.
- b. If working at heights on roofs, etc, do not shine lights from below to illuminate the situation. Workers on roof tops can suffer a temporary loss of night vision from glare and run a great risk of walking off an edge or through a hole in a roof.  
  
If the lights cannot be positioned above the roof, use hand lights or helmet mounted torches only, controlled by the workers at the height.
- c. Should a roof top worker be temporarily blinded or suffer a loss of night vision for any reason, he should stay still and not move until his vision returns.
- d. A rescue scene is better illuminated generally with a soft medium level density light for general movement within the area, with the particular work scene being illuminated with higher intensity lights such as a spot light. Care should be taken to ensure that a casualty is not discomforted by high density lights.
- e. Position lights so that large shadows are minimised.
- f. Keep lighting leads away from dangerous areas where damage is likely to occur.
- g. Lay leads flat so that they do not become an underfoot hazard.

- h. Tape up connection plugs and sockets in extension leads and keep the leads away from water.

9.8 Lighting Efficiency

The following table gives an indication of the efficiency of various lighting systems commercially available, the rated life, indication of comparative costs based on a common 400 watts consumption for each light.

The light or luminous energy is rated in "lumens" which is a visually evaluated radiated energy.

TYPE	WATTS CONSUMPTION	LUMENS OUTPUT	RATED LIFE HOURS	1982 COMPARATIVE COSTS \$
INCANDESCENT (Normal Light Bulb)	400	6960	750	2.50
TUNGSTEN HALOGEN (Quartz Halogen)	400	7500	2000	20.00
FLUORESCENT	400	31500	20000	20.00
LOW PRESSURE SODIUM	400	64500	18000	150.00
MERCURY VAPOUR	400	22500	18000	20.00
METAL HALIDE	400	34000	15000	44.00
HIGH PRESSURE SODIUM	400	50000	20000	75.20

This chart, while it compares the efficiency of various lighting sources, does not give any indication of physical size, spares availability or robustness. Suitability for a particular use is still best determined by an on-the-job test and party leaders are advised to practically test any lighting systems prior to purchase.

## CHAPTER 10

### CUTTING EQUIPMENT

- 10.0 In rescue situations, particularly war related events, obstructions in the path of the rescue worker preventing extrication of casualties will be encountered. The rescue worker needs to be proficient in the many methods of cutting away obstructions, without creating a hazardous situation to himself, his fellow workers and the casualty.

This can only be achieved with regular training, a total familiarity with the tools being used and the hazards which may be encountered. No attempt to practice entry or demolition should be carried out without supervision and a thorough knowledge of the contents of chapters 7 and 8 of this publication - Shoring and Elementary Demolition, Debris, Damage to Buildings and Tunnelling.

#### CUTTING WITH OXY ACETYLENE

- 10.1 When iron or steel obstruction are encountered in the course of rescue work, a rapid means of cutting a way thorough is with the oxy acetylene cutting torch. It should be borne in mind however, that only readily oxidisable steels can be cut by this process although other metals which do not oxidise such as brass, bronze and coppers can be melted away by the high temperatures of the flame.

The use of oxy acetylene equipment is a specialist task and should not be attempted without training and considerable practice in the skill. The equipment is potentially dangerous in the hands of unskilled workers. It must not be used in any environment where gas or other explosive, or flammable material are present.

#### CHAIN SAWS

- 10.2 The chain saw can be a valuable aid to the rescuer provided the machine is used correctly. The operation should be restricted to fully trained operators. Never attempt operations beyond your capacity or experience, without trained supervisors in a non operational environment. There are many brands of chain saws available, but there are two major types:
- a. The petrol motor driven chain saw.
  - b. The electric motor driven chain saw.

It is imperative that the owners manual be thoroughly read, prior to using a chain saw.

10.3

Points to be checked prior to use:

- a. Check the type and mixture of two stroke fuel used in the petrol driven saw.
- b. Check the chain oil lubrication systems, oil type and quantity.
- c. Check the chain brake operation.
- d. Check the starting procedure.
- e. Check the stopping procedure.
- f. Check the spark plug gap and cleanliness (petrol motor)
- g. Check the air filter cleanliness (petrol motor).
- h. Check the fuel cap venting (petrol motor).
- i. Check the fuel tank filter (petrol motor).
- j. Check the saw dust guard and cooling fins.
- k. Check for guide bar wear and oil groove clearance.
- l. Check the chain tension.
- m. Check the chain sharpness.

10.4

Rules for operation

- DO NOT - fail to follow the instructions in the owners manual.
- DO NOT - Start the saw on your leg or knee.
- DO NOT - Drop start the saw.
- DO NOT - Let the moving chain touch your clothing.
- DO NOT - Touch or try to stop a moving chain with your hand - switch off before touching the chain.
- DO NOT - Hand a running saw to another person.
- DO NOT - Approach a person running a saw.
- DO NOT - Allow any person or animal, closer than 3 metres to a running saw.
- DO NOT - Cut with a dull or loose chain.
- DO NOT - Smoke while operating.



- DO NOT - Operate a saw for more than thirty minutes without taking a five minute rest. The vibration from chain saws, cause circulation problems which may result in muscular cramps.
- DO NOT - Refuel a hot saw.
- DO - Start your saw without help - it's a one man saw, use it as such.
- DO - Keep a firm grip on the handles of the saw when starting. It is a two handled operation.
- DO - Start the saw on a firm level surface.
- DO - Turn your saw off when moving between jobs.
- DO - Be aware of kick back.
- MUST - Wear a safety helmet, safety goggles, boots, gloves, earmuffs, and protective dress.
- DO - Have wedges, an axe and an iron bar on hand.
- DO - Keep the chain sharp, oiled and snug on the cutter bar.

#### 10.5 Maintenance

Inspection, basic servicing and maintenance should be carried out on a daily basis when in use or following each operational period. Full servicing after 20 hours operation or as per the manufacturers recommendations is required.

#### 10.6 Chain Maintenance

The care that the chain saw is given will determine the type of service an operator will receive. Chains should be kept clean and sharp for maximum cutting efficiency.

#### 10.7 Chain Tension

Check the chain tension regularly and adjust it as often as necessary to keep the chain snug on the bar, but loose enough to be pulled around the bar by hand. Over a period of time the moving parts of the saw chain may become so worn that it is no longer possible to obtain the correct chain tension adjustment. This is called chain stretch and can be remedied by having a link removed by the Service Dealer.

10.8 Chain Lubrication

Make sure the manual and automatic chain oilers are working. Keep the oiler tank filled with the specified oil. Use plenty of oil on the chain when cutting and never let the chain run dry on the bar.

10.9 Chain Sharpening

A saw chain is a precision manufactured cutting attachment and requires regular inspection and care to maintain peak cutting efficiency. Touch up sharpening may be required during a days hard use, or in some areas where sand and abrasives have become embedded in the bark of trees or where beams are particularly dirty. In these circumstances the cutter teeth may dull more rapidly and regular sharpening may be required.

REFER TO THE MANUFACTURERS SPECIFICATIONS BEFORE ATTEMPTING TO SHARPEN THE CHAIN - EACH MODEL VARIES SLIGHTLY AND REQUIRES A SPECIAL FILE SIZE, GUIDE FOR ANGLE OF FILING AND DEPTH GAUGE

Prior to commencing sharpening procedures, disconnect the spark plug lead as an additional safety measure:

- a. Place the bar in a vice with the engine of the saw resting on the bench.
- b. Use a round file of the correct size and a file guide marked for the correct filing angle. (Refer to Manufactures Specification).
- c. Hold the file at the correct top filing angle, apply pressure against the face of the tooth, and push the file towards the outside of the chain. Release the pressure on the cutting edge on the return stroke. Repeat the sharpening stroke until the tooth is sharp (Figs 146, 147, 148 and 149).
- d. Drop the file into the Gullet and clean out with a few light strokes. Do not touch the cutting edge of the tooth.
- e. Sharpen all teeth on one side of the chain before sharpening teeth on the other side. Use the same number of strokes on each tooth to help keep all teeth the same length. Refer Figs 149 and 150.
- f. The guide bar must be turned over during each major sharpening session
- g. Feathers on the guide bar must be removed by dressing with a fine flat file during each major sharpening session.

n. The saw should be cleared, sharpened and emptied of fuel prior to storage.

After each full sharpening, the depth gauges should be checked with a depth gauge tool and filed down if necessary with a flat file. The leading edges should be rounded off after filing. (Fig 151).

Listed at Fig 152 are some common filing errors which must be corrected by refiling. It is emphasised that touch up sharpening can be carried out by the operator, but full sharpening should only be attempted by a person trained in sharpening chain saws.

Fig 146.

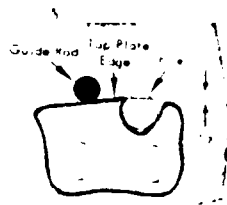


Fig 148.

- 1 Top Plate
- 2 Side Plate
- 3 Depth Gauge Guard
- 4 Gullet

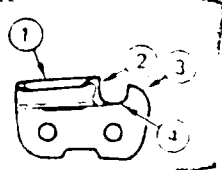


Fig 150

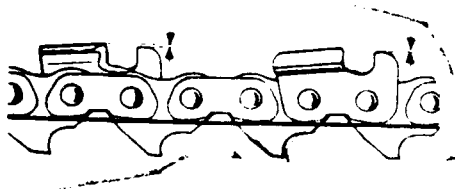


Fig 147

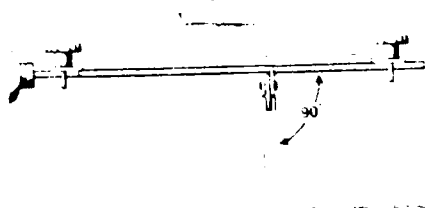


Fig 149

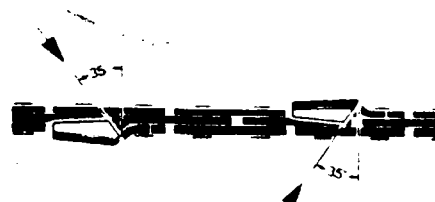
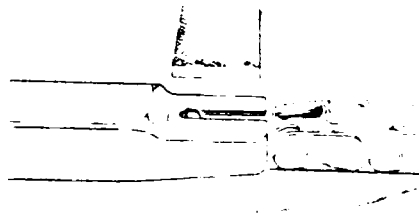


Fig 151



### COMMON FILING ERRORS

All of these errors must be corrected by re-filing.




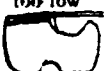
Cutter Fault	Cause	Result
<b>Hook</b> 	(a) File too small. (b) Handle held too high.	Dulls quickly and will not cut smoothly.
<b>Backslope</b> 	(a) File too large. (b) Handle held too low.	Cuts slowly and requires extra pressure.
<b>Depth Gauges too high</b> 	Not filed down.	Cuts slowly, requires extra pressure and leads to cutter damage.
<b>Depth Gauges too low</b> 	Too much filing.	Rough cutting, requires more power (cuts too deep).

Fig 152

### CUTTING TECHNIQUES

10.10 On all chain saws, the chain travels in the same direction. At the upper edge of the guide bar, the chain runs out and away from the engine towards the tip of the guide bar, where it goes around and down to the lower edge and back to the engine. Therefore either the upper or lower edge or tip can be used for cutting.

Before cutting, check these points:

- Place both hands on the saw
- When holding the saw, use a normal overhand grip on the bar with the thumb beneath the bar.
- Stand slightly to one side of the saw, not directly behind it, to minimise injury from potential kickbacks.
- Ensure your feet are planted firmly - Do not stand on ladders when using the saw.
- Bring the saw to full throttle before cutting.

10.11 Chain Brakes

Where the saw is fitted with a chain brake, this device must be disengaged by pulling the lever back towards the operator before starting the saw.

The brake is designed to be activated automatically on impact with the operator's hand and forearm on the forward handle as the saw kicks back. The brake stops all chain movement immediately it is activated.

The chain saw must not be operated with the chain brake engaged.

10.12 Kick-Back

"Kick-Back" is the common term used to describe the action that occurs when the tip of the cutter-bar or the upper edge of the cutter-bar contacts an obstruction. This is more pronounced when the tip contacts the obstruction such as a branch and jumps upward and to the rear.

This action causes the operator's forward hand and wrist to contact the chain-brake operating lever, causing the chain to stop rotating instantly.

However, even when the chain is stopped, serious injury can still occur due to the cutter-bar striking the operator, usually in the facial area.

NOTE: Inexperienced operators should not attempt to "under-cut", or use the tip of the cutter-bar to initiate a cut.

10.13 Cutting with the Lower Edge

This is the most common and natural position used in the cutting. Simply hold the saw firmly in both hands and let the saw cut into the timber. Do not use a see saw action or a back and forth action, because as the saw cuts it will draw itself towards the timber being cut. Allow the saw to move forward until the casting of the engine housing touches the timber and as the chain cuts, the chain saw will slide down the timber being cut. On most chain saws there is a set of spikes protruding from the front of the saw near the chain. These spikes are situated so as to assist in holding the saw firmly against the timber. As the timber is cut, pull back slightly on the handles and reposition the spikes lower down the log.

10.14 Cutting with the Upper Edge

Under certain conditions, the upper edge of the guide bar may have to be used for cutting. This is called undercutting and obviously the saw must be lifted to advance the cut.

Due to the rotation of the chain, there will be some counteraction of the saw chain and the saw will tend to push back towards the operator. Always use both hands on the saw and place the feet firmly on the ground.

10.15 Cutting with the Tip

It may be necessary during debris clearance or limbing of dangerous trees, to use the tip of the chain saw for cutting. All other alternatives should firstly be considered before undertaken this technique.

The operator must be very careful, because the chain travels at around 1 km per minute and the counter action can cause a severe kickback or kick upwards if the chain should hook up on the wood or hit a foreign object.

10.16 Felling a Tree

It may be necessary to fell a tree which is in a dangerous situation or to use the timber for an A Frame or jib during rescue operations. Inexperienced operators should not attempt felling large trees, trees in bad condition or trees which are in difficult locations.

10.17 Some Rules before Starting:

- a. Think first, then cut safely and take no risk.
- b. Decide before hand which retreat path to follow when the tree begins to fall.
- c. Check the tree to be felled, to see if there are dead branches or loose bark which may be dislodged.
- d. Clear the area around the tree. Make sure you have good footing and hold the saw firmly.
- e. Stand just to the side of the saw, felling the tree.
- f. Cut at high engine speeds only (full throttle).
- g. Ensure that there is nobody in the vicinity of the work site.

10.18 Felling

The direction of fall is controlled by the undercut. Fig 153 shows a typical method for small trees. The 45° notch is cut about one third of the diameter of tree. The felling cut (3) should not cut right through to the notch, as the uncut band of wood acts as a hinge on falling. When the diameter of the wood is greater than the saw bar length, two cuts should be made as in Fig 154.

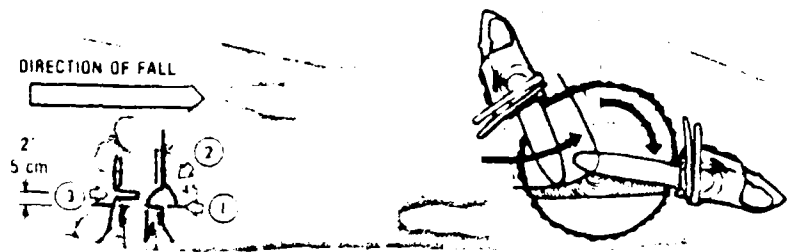


Fig 153

Fig 154

10.19 The Lay of the Timber to be Cut

The timber to be cut, be it a tree across the roof of a house, rafters or beams encountered while clearing debris, will often be in very awkward positions with stresses being imposed on various sections. There are four basic conditions which can characterise the lay of timber in Rescue Work.

- a. Top Bind
- b. Bottom Bind
- c. Side Bind
- d. Drop

The technique for cutting timber in these situations is similar, but the sequence of cutting varies with each type.

10.20 Top Bind (Figure 155)

The weight of a tree or beam which is supported at both ends, but is suspended over a dip e.g. a tree leaning on a house. The first cut is made on the top to a

depth of approximately one third the diameter. The second cut is made from below (undercut). If the cutting was started at the top, the saw bar would be pinched out before the cut could be finished.

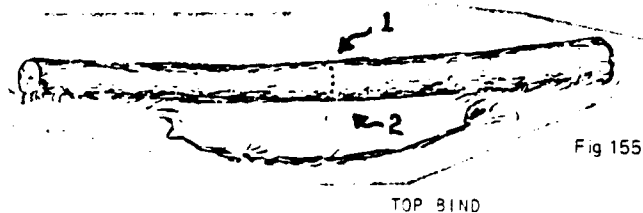


Fig 155.

10.21 Bottom Bind (Figure 156)

Bottom bind occurs when a beam is lying over some solid object with a substantial over hang on one end.

When a beam or tree is in this position, the top side is under tension, while the bottom is under compression. The operator should start his cut where the bar will pinch out first i.e. the bottom of the tree. This should be under cut about one third through and the finishing cut made from the top where the Kerf opens up, as the saw cuts through.

BOTTOM BIND

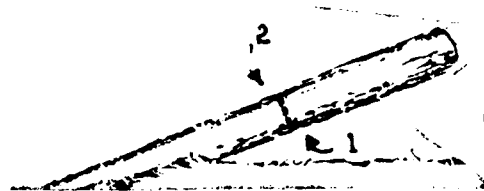


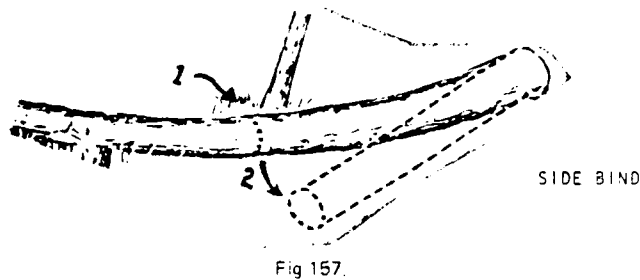
Fig 156.

10.22 Side Bind (Figure 157)

A side bind is a situation where a beam is supported at both ends with another object (e.g. a beam) located somewhere in between, with the result that the beam is under stress and strung like a bow. Should this beam be cut, it will spring away very rapidly. As the wood is cut, the side which will swing out will open up, while the side on which the operator must stand will be compressed. A cut is made in the compressed side first to about one third the depth of the beam. The second cut is made on the off side.

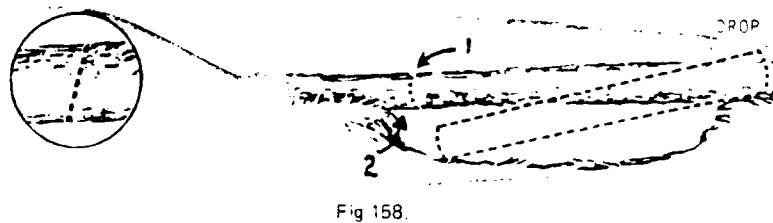


If the bind is extremely heavy, a Vee cut should be made to prevent splintering. Great care should be taken with this technique.



10.23 Drop (Figure 158)

This condition exists when one end of the beam or log to be cut is supported, while the other end is not. The cut is made as for a top bind, except that it will be made at a slight angle, slanting away from the end which will drop. If the cut isn't made on an angle, the falling part will wedge the saw bar against the stationary end.



HYDRAULIC CUTTERS

- 10.24 There are a number of hydraulic cutters commercially available, ranging from the very expensive and sophisticated Hurst Rescue Tool, to cutters or shears with a force of around 9 tonnes and jaw opening sizes of around 10-12 cms. In most cases, these cutters and shears can be operated from the standard issue Hydraulic Equipment described in Chapter 5, but compatibility between brands and models should be checked prior to any purchase.

It is important when using cutters, to start and keep the jaws of the cutter at right angles to the material being cut, to prevent excessive load on the jaw pins when cutting sheet metal, because unless the bite is at right angles there is a tendency for the thin metal to skid between the blades.

The manufacturer's handbooks and recommendations must be carefully studied prior to commencing any cutting operations, and all operating procedures and safety measures must be strictly observed.

10.25 DEMOLITION HAMMERS (Figure 159)

These machines are now generally available electrically driven, as well as the larger air driven types requiring a compressor.

The electric hammers are light weight (around 10kg), deliver approximately 2000 blows per minute to the surface being cut or demolished and can be supplied with a range of points, chisels or rotary drill attachments. They can be used to cut concrete, asphalt, clay brick and other softer building materials and are a valuable aid in gaining access to brick or pre-stressed concrete buildings where casualties may be trapped.

Operation is from the 240 volt main supply or a generator capable of a power output of 1000 watts or better.

No special skills are required to operate the hammers, but practice in the skill of entry and demolition is necessary to achieve the best results. Eye and ear protection must be worn.



Fig 159.

#### MOTOR DRIVEN SAWS

##### 10.26 Rotary Saws (Metal and Masonry Cutting) (Figure 160)

This saw can be used to cut through metal and concrete very quickly and as with other cutting tools, the cuts must be made at right angles to the surface. The rotary saw can be dangerous in certain conditions, because it throws out sparks and pieces of rotating blade if the user is not extremely careful. It should never be used in a gas environment, where petrol has spilled or is stored, or where a victim is likely to be injured by the waste from cutting.

Only experienced operators should attempt any operational work with this tool and full protective dress including safety goggles must be worn at all times.

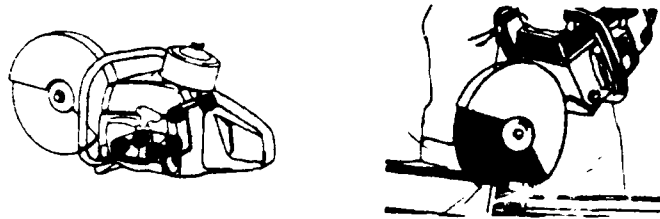


Fig 160.

##### 10.27 Rotary Saws (Circular Saws) Wood Cutting

These tools can be a valuable aid in debris clearance and tunnel construction, if a power source is available.

The blade guard should always be used and the saw permitted to cut at its own speed. i.e. do not force the blade into the timber to the extent that the machine slows down, as this is detrimental to the machine motor and to the blades. Circular saw blades like any wood or metal saw must be sharp and have the correct "SET" on the blades for efficient cutting. Have the blade maintained periodically. Do not at any stage permit the electrical cord to stray in front of the operator; the danger of cutting the cord and being electrocuted is very real. One rescue member should be designated "CORD KEEPER" and ensure that the cord is always clear. Eye protection must be worn at all times.

10.28     Reciprocating Saws (Jig Saws)

When equipped with a good quality heavy duty blade, a reciprocating saw can be of assistance in cutting metal or wood sheeting in particular. The cut should be made at right angles to the surface and the sole plate in contact with the metal being cut. Eye protection must be worn.

HAND TOOLS FOR CUTTING

10.29     Bolt Cutters

Bolt cutters come in a variety of sizes and styles, but most are quite capable of cutting through 8mm mild steel without great effort. This makes the tool extremely valuable for debris clearance, in reinforced concrete and removal of padlocks and security grills in areas where it is suspected casualties may exist.

10.30     Hack Saw

A good hack saw with new blades can assist the rescuer in many situations, particularly if he knows how to use the tool correctly. One of the problems often encountered, is that the blades have a tendency to bind when cut lengthens and the metal being cut starts to move. To relieve this situation, always cut at right angles to the job, use a wedge to alleviate pressure on the blade and tap it in progressively as you cut. Cut as close to a supported section of the metal being cut, as is possible, in order to eliminate movement of the metal caused by the cutting action. If the metal being cut is under tension, mechanical or hydraulic jacks should be used to reduce the load on the saw blade.

10.31     The Axe

A versatile tool in many rescue situations which can be used to cut timber or sheet metal. When used to cut sheet metal, the axe should be driven into the sheet so as the blade penetrates to approximately half the depth of the cutting surface. The handle should be pulled upwards so that the head is almost parallel with the metal. A second rescue member should drive the axe head down with a sledge hammer while the first guides it with the handle.

This technique can be used for cutting through galvanised corrugated iron and similar construction materials. It is also used for gaining access through the roof of a vehicle.

10.32      Hand Saws

Other types of hand saws such as the Bow Saw, General Purpose Saw, Rip Saw, etc, all have a part to play in the rescue tool kit and should not be neglected. Remember to train with the hand tools, because in a disaster it may be all you will have.

CHAPTER 11

FIRES AND ELEMENTARY FIRE FIGHTING

- 11.1 In rescue situations involving fire, it is the Fire Services responsibility to extinguish the fire and Rescue personnel would not normally commence operations until advised by the Fire Service, that is it safe to do so. There is, however, every chance, particularly in a war situation, that rescue personnel may be the first to arrive at an incident involving a fire in its initial stages, or more likely that they may have to deal with small fires occurring during rescue operations.

A basic knowledge of fires, fire fighting techniques and equipment is therefore of great importance to rescue personnel.

THE CHEMISTRY OF FIRE

11.2 Definition

Fire is a chemical reaction or series of reactions, in which heat, smoke, and sometimes light, are produced. If the reaction is very slow only heat, and a slow oxidation occur. Rusting is a good example of this. When the reaction rate is rapid, light (flame) is given off, as well as heat.

11.3 Chemistry

For fire to occur three elements are necessary, viz:

- a. Fuel
- b. Oxygen
- c. Heat

The above elements can best be discussed in terms of the "Triangle of Fire", (See Figure 161). Fire will continue as long as the three elements are present; removal of any one of them causes the triangle to collapse, and the fire goes out.

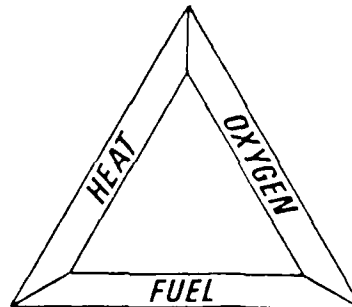


Fig 161

### Categories

11.4 Fire may be categorized into four separate stages. These are:

- a. Incipient Stage. In this stage, the fuel is heated to the point where small particles of invisible smoke or gas are given off. There is no appreciable heat at this stage.
- b. Smouldering Stage. As the products from the incipient stage increase, and further combine with oxygen, smoke becomes visible.
- c. Flame Stage. Here the flammable vapours given off in the first two stages, ignite. Actual fire now exists; appreciable amounts of heat are not yet present, but follow almost instantaneously.
- d. Heat Stage. Uncontrollable heat and rapidly expanding air now complete the original combination of the elements of the "Triangle of Fire".

### CLASSES OF FIRE

11.5 Fires are classified according to the nature of the fuel involved. There are currently four classes of fire:

- a. Class 'A'. These are fires involving solid material of an organic nature, namely carbon compounds such as wood, paper, cloth, etc. They are the most common class of fire.
- b. Class 'B'. Fires involving liquids or liquefiable solids such as petrol, oil, grease, paint, fat, thinners etc.
- c. Class 'C'. This class of fire involves gases in either vapour or liquefied form, either as a spillage of the liquid or leak of vapour. Methane, propane, butane, etc. are examples of likely fuel.
- d. Class 'D'. Fires involving metals such as magnesium, aluminium, sodium or potassium.

In the past, electrical fires were given a classification. According to present day ideas, electrical fires do not warrant a separate class since any fire started by, or involving electrical equipment, will in fact be a Class A, B, C or D fire; the electrical equipment is simply either the ignition source and/or part of the total fire.

#### THE CHEMISTRY OF FIRE EXTINCTION

- 11.6 In dealing with the chemistry of fire, through the "Triangle of fire", it was shown that three elements are essential for fire to occur, viz: fuel, heat and oxygen.

The principles of fire extinction simply consist of the elimination or limitation of one, or more of the three elements. We can therefore conveniently classify these principles under the following headings:

- a. Starvation, or the elimination of fuel.
- b. Smothering, or the limitation of oxygen.
- c. Cooling, or the reduction of temperature.

As an aid to remembering the above three principles, we can again apply the triangle. (See fig 162).

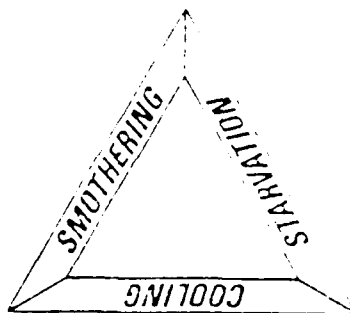


Fig 162.

In practice, specific methods of extinguishing fires often involve a combination of more than one of the three principles, but it is convenient to examine each according to the main principle involved.

#### 11.7 Starvation

This method can be applied in one of the three ways:

- a. By removing combustible material from the vicinity of the fire, e.g. back burning in a bush fire, draining of fuel from burning tanks, or removing cargo from a burning truck.
- b. By removing the fire from the vicinity of combustible materials, e.g. dragging a burning car from a car park, covering and removing a burning bin from an office, or dynamiting an oil well fire.



- c. By sub-dividing the burning material, whereby the smaller fires produced can be left to burn out or be more easily extinguished by other means. A good example of this technique is the use of beaters in a bush fire.

11.8 Smothering

If the oxygen content of the atmosphere in the immediate vicinity of a fire can be sufficiently reduced, the fire will go out. The general idea in this method is to prevent the access of fresh air to the fire, allowing the fire to reduce the oxygen content in the confined atmosphere, until it starves itself to extinction.

Some examples of the smothering principle, both simple and large scale are as follows:

- a. Snuffing out a candle.
- b. Smothering a person's burning clothing with a blanket or rug.
- c. Covering a small class 'B' fire with earth or sand.
- d. Applying fire fighting foam or dry powder to a large Class 'B' fire.
- e. Capping a burning oil well.

11.9 Cooling

If the rate at which heat is generated by a fire, can be made less than the rate at which it spreads through the fuel, the fire cannot sustain itself. To do this, we must speed up the rate of heat removal from the fire, thus reducing the temperature of the burning material, and therefore the rate of heat production. Eventually heat loss exceeds heat production, and the fire goes out.

The best example of this, the most simple and fundamental principal of extinction, is the application of a jet spray or water; it is the method most commonly employed. Whatever the agent used, it operates by absorbing heat from the fire, as a result of which it may undergo one or more of the following changes:

- a. it's temperature is raised;
- b. it is converted to vapour;
- c. it decomposes; or
- d. it reacts chemically with the burning material.

11.10 FIRE FIGHTING APPLIANCES

Ever since early man discovered the simple technique of extinguishing a fire by the application of water, the design and development of fire fighting appliances has become a highly efficient operation. It is not intended to make rescue personnel fully fledged firemen, therefore this section will only deal with portable, or "first aid" type fire extinguishers, such as are readily found in most commercial, industrial, educational and domestic buildings and areas.

Portable fire extinguishers can be divided into five categories, according to the type of extinguishing agent they contain, namely:

- a. water types
- b. foam types
- c. vapourising liquid types
- d. dry powder types
- e. carbon dioxide (CO<sub>2</sub>) types.

Over the years there emerged a veritable mass of portable fire extinguishers within each of the categories listed above, particularly in the water and foam types. We therefore had soda acid, water gas, stored pressure, turnover foam, chemical foam, mechanical foam, and so on, to the utter confusion of the layman who may have had to select and use one once in a lifetime. In an attempt to standardise on types, and thereby cut out confusion, the Australian Fire Board has settled for one particular model of extinguisher within each type, particularly the water foam and vapourising liquid types. Further standardisation and simplification of operation, particularly to assist untrained operators, has been introduced, in that, irrespective of type, the operating procedures will be:

- a. pull safety pin
- b. squeeze handle
- c. aim hose nozzle at the fire.

CHARACTERISTICS, OPERATION AND APPLICATION

11.11 Water Type (Stored Pressure)

- a. Colour Code. Red, or stainless steel with a red band.
- b. Capacity: 10 litres of water.

- c. Operation: The container is pressurised to 150lb/sq.in. with dry air. When the safety pin is pulled and the handle squeezed, the water is forced out of the container and through the hose.
- d. Application: Class 'A' fires only. DO NOT USE ON FIRES INVOLVING ELECTRICITY.

11.12 Foam Types (Stored Pressure)

- a. Colour Code. Blue, or stainless steel with a blue band.
- b. Capacity: 10 litres of water and AFFF foam solution in a ratio of 15 to 1.
- c. Operation: Identical to the water (Stored Pressure) type.
- d. Application: Class 'B' fires only, although in an emergency they can be used on Class 'A' fires. DO NOT USE ON FIRES INVOLVING ELECTRICITY.

11.13 Vapourising Liquid Type

This type of extinguisher uses a chemical known as a halogenated hydrocarbon, or "halon", stored as a liquid under pressure, and released in such a way as to vaporise rapidly in a fire zone.

- a. Colour Code: Yellow.
- b. Capacity: The most widely used halon is BCF, (bromo-chloro-diFluro-methane) and at "first aid" level can be found with capacities of 1kg up to 8kg.
- c. Operation: The liquid BCF is stored under pressure with nitrogen. Pulling the pin and squeezing the handle or lever discharges the liquid which then vapourises.
- d. Application: Primarily for small class 'B' fires; although they also may be used on class 'A' fires. They are less efficient than water when a cooling effect is required. In addition, BCF, being non-conductive is safe and suitable to use on fires involving electrical equipment.

11.14 Dry Power Type (Stored Pressure)

- a. Colour Code: Red with a white band.
- b. Capacity: From 2.25kg to 13.5kg of a powder based on either sodium bicarbonate or ammonium phosphate.

- c. Operation: As for the water and foam types. Some earlier models which may be encountered, contain a small cylinder of carbon dioxide to provide pressure to expel the powder.
- d. Application: Class 'B' fires and fires involving electrical equipment. They may also be used on small class 'A' fires, but this is not recommended.

DO NOT USE ON CLASS 'D' FIRES

11.15 Carbon Dioxide (CO<sub>2</sub>) Type

Although CO<sub>2</sub> type extinguishers have been in use for many years, primarily for Class 'B' fires and fires involving electrical equipment, they are generally being phased out in favour of BCF or Dry powder types:

- a. Colour Code: Red, with a black band.
- b. Capacity: Standard sizes ranged from 10-25lbs.
- c. Operation: As for all other types above. The carbon dioxide is stored in the container as a liquid under pressure. On release to atmosphere it converts to a "snow" like gas, which applies the extinction principle of smothering.
- d. Application: Class 'B' fires, and fires involving electrical equipment.

11.16 Hose Reel

Although it is not strictly a portable extinguisher, there is one other appliance of the water type, that will be found in many areas. This is the First Aid Hose Reel, consisting of 23-36 metres of 20mm hose wound in a red coloured metal reel, and attached to walls, pillars, etc, or mounted in wall cabinets. The reel may be fixed, or able to be pivoted out of a cabinet or from a wall.

One person can quite capably operate this appliance; the basic procedure is as follows:

- a. Ensure that the nozzle or jet is in the closed position.
- b. Turn on the main valve (most reels have a device which retains the nozzle until the main valve is open).
- c. Pull the hose off the drum, towards the fire.
- d. Open the nozzle or valve, and direct the stream of water at the fire.

11.17 Rating of Fire Extinguishers

On modern portable extinguishers will be found a label giving an effectiveness rating for that type of extinguisher. This is of vital importance to an operator when he has to assess the capabilities of an extinguisher against the size of the fire he has to deal with. For extinguishers to be used on Class 'A' fires, this rating is expressed as the length of fire that it can extinguish; for class 'B' fires it expresses the volume of liquid that can be extinguished.

Some examples of ratings are as follows:

- a. Rating - 27A. This appliance is capable of extinguishing a class 'A' fire of 2.7 metres length.
- b. Rating - 34B. This appliance is capable of extinguishing a class 'B' fire, containing 34 litres.
- c. Rating - 5BC. This appliance is capable of extinguishing a Class 'B' fire containing 5 litres, and can be used on Class 'C' fires.

NOTE: Rating is based on use by a trained operator, in still air.

11.18 Hazards Associated with BCF

BCF is a highly efficient extinguishing agent, but like many chemicals, it does have harmful side effects on humans if used incorrectly or indiscriminately. It will be of value to potential operators of this type of appliance to understand some of the hazards associated with its use.

Volunteers exposed to a 4-5% concentration of BCF, for one minute suffered definite effects. These included:

- a. light headedness
- b. difficulty in mental concentration
- c. slight disturbance in balance and reaction time
- d. slight tingling of fingers and toes.

The above reactions were caused by the two principle toxic actions of BCF: It can stimulate or depress the central nervous system, to produce effects ranging from tremors and convulsions, up to lethargy and unconsciousness.

It can sensitize the heart to adrenalin, causing disorders ranging from a few isolated abnormal beats, through a series of abnormal beats, right up to complete disorganisation of the heart's normal rhythm.

Within the first thirty seconds of exposure little effect is noticed, but the effects can appear quite rapidly after this time. The initial onset can be compared to a feeling of drunkenness or anaesthesia, with the attendant impairment of mental and physical performance.

Exposure to concentrations greater than 5% of BCF, carries the risk of unconsciousness or death; therefore it can be said that the concentration of 4-5% BCF for one minute, is the maximum safe limit for human beings. First aid for suspected exposure to concentrated BCF is simple: get the victim to fresh air as quickly as possible. Recovery will be rapid and complete.

If it is necessary to use a BCF extinguisher in a confined space, the operator should ventilate the space and move to fresh air as soon as possible after the fire has been extinguished.

ANNEX

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